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NEW OBSERVATIONS ON THE ORIGIN OF THE GALÁPAGOS ISLANDS, WITH REMARKS ON THE GEOLOGICAL AGE OF THE PACIFIC OCEAN.

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In December, 1890, I wrote a paper,[1] "On the origin of the Galápagos Islands," which was published in the AMERICAN NATURALIST of March and April, 1891, one month before I left for the archipelago. This paper opens with the following remarks: "All islands can be divided into two principal groups: 1. Islands developed from continents or larger bodies of land through isolation or subsidence—*Continental Islands.* 2. Islands not developed from continents, but from submarine portions of the earth—*Oceanic Islands.*

"The flora and fauna of the first group will be more or less *harmonic*—that is to say, the islands will be like satellites of the continent from which they developed, and the whole group comparable to a planetary system. The flora and fauna of the second group will be *disharmonic*—that is to say, it will be composed of a mixture of forms which have been introduced accidentally from other places. It is evident the first group of

[1] Baur, G. "On the Origin of the Galapagos," AMERICAN NATURALIST, March, 1891, p. 217-229; April, 1891, p. 307-326.

islands will be affected gradually in the same way; there will be immigrants from other localities besides the original inhabitants.

"*Continental islands, therefore, may be composed of two floral and faunal elements: first, an original (endogenous) one; and second, a secondary (exogenous) one. Oceanic islands, however, will only contain a secondary (or exogenous) floral and faunal element, they never will show harmonic distribution.*"

By the study of the Galápagos Islands I reached the conclusion that the distribution of the animals was harmonic, and that the theory of the oceanic origin was therefore not correct.

This opinion I have sustained in the following papers: 1. Das Variiren der Eidechsen-Gattung Tropidurus auf den Galápagos Inseln., Biol. Centralbl., Vol. X, 1890, p. 475–483. 2. Account of my Trip to the Galápagos Islands, dated Chatham Island, August 28, 1891, Amer. Nat., Vol. XXV, 1891, p. 902–907. 3. Ein Besuch der Galápagos Inseln., Biol. Centralbl., Vol. XII, 1892, p. 221–250, also H. de Varigny. Voyage scientifique aux Isles Galápagos, Revue Scientif., Vol. 50, No. 13, 24 Sept., 1892, p. 391–400. 4. Das Variiren der Eidechsen-Gattung Tropidurus auf den Galápagos Inseln. Festschrift zum siebenzigsten Geburtstage Rudolf Leuckart's, Leipzig, 1892, p. 259–277, 4° (with variation curves). 5. The Differentiation of Species on the Galápagos Islands and the Origin of the Group, Biol. Lect. Marine Biol. Laborat. Wood's Holl., 1894, Boston, 1895, p. 67–78.

In this last paper I gave a table showing the distribution of seven genera on the Galápagos Islands; I also gave a table of the distribution of seven genera of birds on the West Indies. Since the West Indies show harmonic distribution, and since it is proved that they were formed by the splitting up of a continuous land area, the same must be true for the Galápagos.

This paper has been reviewed by Professor F. Ratzel in Leipsic, Professor S. Günther in Munich, and Professor O. Böttger in Frankfort. They all agree with my view. Ratzel says: "Baur concludes from the 'harmonic distribution' of the variations that the Galápagos, like the Antilles, originated by sinking of the sea bottom, and were certainly not formed by

single volcanic islands, that they were formerly connected through Cocos Island with Central America." He correctly rejects the hypothesis of the consistency of continents and oceans. (Dr. A. Petermann's Mitteilungen, 1895, Heft 12, p. 184–185.)

Günther[2] remarks: "It is known and generally admitted, that for the solution of the question about the origin of a certain island, or a group of islands, the application of zoogeography is of the highest value. The paper before me shows how important it will be for physiography, if correctly applied. Professor Alexander Agassiz had insisted that the Galápagos Islands never had been in connection with the American continent, but were typical volcanic islands. But, if the single islands are all of marine origin, if they were occupied only later by organisms from the continent, fauna and flora ought to show a pretty variegated aspect, making an impression of a mixture of forms. There would be no reason, why one of the islands, which are all closely placed together, should have been preferred to another one, if really the currents of the air and the sea alone effect the transportation of organic germs.

Baur's detailed examination revealed a totally different picture. He showed that each, or nearly each island has peculiar representatives of certain genera, Tropidurus, birds, etc. This can only be explained by subsidence. The tables given by Baur of the distribution cannot be misunderstood. The Galápagos must be considered as the remains of a Miocene land—connection with the continent, to which belonged probably also the West Indian Archipelago."

Böttger[3] also agrees with me, and finishes his review with the following sentence: "Baur finally reached the conclusion, that the lines of the continents of former geological periods do not agree at all with those of the present continents, the more we go back in geological time the larger are the differences." "With this theoretical exposition he gives us an interesting example, that by biological research deductions can be made for geological problems."

[2] Günther, S. Naturwissensch. Rundschau, 1895, No. 42, p. 542–543.

[3] Böttger, O. Zoolog. Centralbl., I, No. 15, p. 401–463, Sept. 2, 1895.

Ortmann[4] is of the same opinion, and referring to my papers, he says: "The Galápagos Islands may be considered a classical example of the influence of separation for the formation of species."

Meanwhile Mr. Townsend's[5] paper on the Birds of Cocos Island had appeared, the results of which showed to be very interesting for the question of the origin of the Galápagos.

Dendroica aureola Gould, *Cocornis Agassizi* Townsend, *Nesotriccus ridgwayi* Townsend, and *Coccyzus ferrugineus* Gould were found, the last species having only been known before. *Dendroica aureola* Gould occurs also on the Galápagos, besides it has been recorded on Gorgona Island, on the southeast coast of Columbia, north of Tumaco; at Esmeralda, Ecuador; and Posorja, north of the Island of Puna, in the Gulf of Guayaquil; in western Peru, at Santa Lucia and Tumbez. *Cocornis Agassizi* Townsend is the representative of *Cactornis* (Gray) of the Galápagos, and *Nesotriccus ridgwayi* Townsend very close to *Myiarchus magnisostris. Coccyzus ferrugineus* Gould is related to species of Central America and the West Indies. *Cocos Island* is placed between the Galápagos and the Cordillera de Veragua. The 1500-fathom line probably embraces Cocos Island and the Galápagos from the Island of Coiba.

We shall now consider the botanical evidence.

During my visit of the Galápagos (June 10–September 6, 1891) I collected plants on Albemarle, Indefatigable, James, Chatham, Charles, Hood, Gardner, Bindloe, Abingdon, Barrington, Tower and Jervis. These have been determined at the Gray Herbarium of Harvard University by Mr. B. L. Robinson and J. M. Greenman.[6]

[4] Ortmann, Arnold E. Grundzüge der marinen Thieregographie, Jena, 1896, p. 29; and "On Separation, and its Bearing on Geology and Zoogeography," Amer. Journ. Science, Vol. II, 1896, p. 63–69.

[5] Townsend, C. H. Birds from Cocos and Malpelo Islands, with Notes on the Petrels obtained at Sea. Bull. Mus. Zool., Harvard College, Vol. XXVII, No. 3, Cambridge, July, 1895, p. 121–126.

[6] Robinson, B. L., and J. M. Greenman. Contributions from Gray Herbarium of Harvard University, New Series, No. IX, I. On the Flora of the Galápagos Islands, as shown by the Collections of Dr. G. Baur, Amer. Jour. Science, Vol. L, August 1, 1895, p. 135–149.

From this paper I quote the following: "It is well known not only that the archipelago possesses a peculiar and remarkable vegetation, but that the different islands exhibit in their floras a striking individuality." "While upon some of the smaller islands Dr. Baur collected only a few species, enough material is at hand not merely to confirm strongly the view that almost every island has its peculiar species and varieties, but to show clearly that even plants, which must pass as the same species, often exhibit, when found upon several islands, more or less striking racial differences. These facts, while in other respects noteworthy, derive a special interest from their relation to the probable origin of the flora of the group. Regarding the fauna Dr. Baur has in several recent articles called attention to peculiar harmonic relations existing between the forms of the different islands, and has argued from zoological grounds that the islands must at one time been united, not only with each other but with the mainland near Central America." "This view has been severely criticised by several writers, but no one has attempted to account for the peculiar distribution of differing, yet closely related forms upon the islands, and as the subject is one which merits further attention, it seems worth while to present the botanical data in some detail.

Perhaps no species to be found upon the different islands better illustrates the noteworthy racial divergence in related forms than *Euphorbia viminia* Hook. fil. This species differs markedly in foliage from any other known member of this large genus, and is characteristic of the Galápagos Archipelago. Being essentially a desert plant, it can subsist even upon those islands of the group which are of low altitude and do not attain the upper regions of moister atmosphere. It was first collected by Macrae upon Albemarle, rediscovered by Anderson on Charles, and has now been collected by Dr. Baur on the following islands: Barrington, Chatham, Southern and Eastern Albemarle, James, Jervis, Bindloe, Tower and Abingdon. Even the most cursory inspection of the forms from these different islands discloses marked variation in the contour, size, thickness, rigidity, and color of the leaves, as well as in the length of the intenodes, color of the stem, etc., while more

careful examination shows that these are not mere individual differences, due to chance, state of development, or individual environment, but each form appears in general to be restricted to a single island. Some forms, such as those from Abingdon and Tower Islands, differ rather strikingly from the rest, while others present slighter differences, in a few cases too slight, that a series of careful measurements is necessary to demonstrate their existence. But the examination of considerable number of specimens, such as those secured by Dr. Baur, shows that the species as it occurs on each island differs in some characteristics, slight or more considerable from the forms of all or nearly all the other islands, and furthermore, each island appears to have only *one form* of its own.

The question at once presents itself: If this archipelago is composed of islands of elevation, built up from the sea-floor independently by volcanic action, how has such a distribution been effected? If the vegetation has been derived from the mainland by the chance of transportation of seeds, it is quite impossible to believe that each island has received a slightly different form of the same species, and we are forced to the much more natural assumption that racial and varietal divergence has come about after the introduction of the species upon the islands. Now, continuing the supposition that these are islands of elevation, the seeds of *Euphorbia viminea* must have reached them in one of two ways: either each of the nine islands, where we know the species now to occur, must have received its seed directly from the mainland; or, what is much more natural, seed must have reached one or more of the islands, and from there spread to the rest. That the same species should have reached all these islands presupposes a considerable facility of transportation. But as soon as this is granted it is impossible to understand the highly individual development of the forms upon the different islands. For relative or complete isolation seems necessary to account for the racially divergent floras of the islands; and especially for the occurrence of only one form upon each island. It would thus appear necessary, in accounting for the present distribution, to assume that at one time in the remote past the islands were

either united, or at least that the channels which separate them were less formidable barriers to seed transportation than at present, so that general distribution of species could have been effected; and that subsequently, as the islands separated, or as the channels through some change of currents, or other cause, became less easily passed, an era of *much* greater isolation of the floras of the different islands came about. The divergence of character of the vegetation would then begin at once, and the otherwise unaccountable existence of a single and peculiar form upon each island would be readily intelligible."

While not prepared to make any positive assertion regarding the probable origin of the islands, the authors fail to see in the hitherto generally accepted theory of elevation any satisfactory explanation for the harmonic yet divergent floras of the different members of the group. Upon Dr. Baur's assumption of a former union between the islands and subsequent separation by subsidence, not only is explanation possible, but the existing flora of the archipelago is just that which would most naturally result from such an origin. A former union of the islands would account at once for the occurrence of identical ancestral species upon the different members of the group, and the subsequent separation give the needed isolation for varietal and racial divergence, while the latter could not have come about if a continental interchange of seeds were taking place from island to island.

Regarding a former land-connection with the continent, which would certainly offer much greater geological difficulties, the botanical evidence is still too vague to merit regard. The affinities of the vegetation of the upper, moister portions of the islands are doubtless, as has been assumed, with the floras of Columbia, Central America, Southern Mexico, and the West Indies, while much of the desert flora of the lower regions has doubtless been derived from the arid regions of Chili and Peru. But, so far as botanical data are concerned, this could have come about either by migration by land or by transportation by oceanic currents, and, as the latter still exist, it seems unnecessary to assume the former. However, on this point, the evidence from the vegetation appears to be still wholly indecisive.

The harmonic relation of the floras of the different islands, which, as we have seen, appears to have such an interesting bearing upon the former possible connection of the islands with each other, is shown not only by *Euphorbia viminea*, but by various other endemic species and groups of species of the same and other genera and orders.

All the Galápageian species of *Euphorbia* for instance, with the exception of *E. amplesicaulis* Hook. fil., form a closely related group, doubtless having a comparatively recent common ancestry; but most of these forms are characteristic of particular islands. The same is eminently true of the different species of *Acalypha*. The *Borreriæ* of the Galápagos Islands also form, for the most part, a close group of very nearly related species, or, perhaps, better varieties of one polymorphous species, all of which have probably diverged from a uniform parent stock after the separation of the insular floras from that of the mainland and from each other. Here, however, we find in some instances the same form upon two or more of the islands, as though transportation of the seed had offered somewhat less difficulties than in the case of *Euphorbia viminea*." The forms of *Euphorbia viminea* Hook. fil. are as follows:

Forma *Albemarlensis* (typica).[7]—Albemarle Island; collected first by Macrae, and again by Dr. Baur, on the southern end of the island in July, and on the eastern side in August, 1891.

Forma *Jacobensis*.—Collected by Dr. Baur near Orchilla Bay, Northern James Island, August, 1891.

Forma *Castellana*.—Collected on Tower Island, by Dr. Baur, September 1891.

Forma *Chathamensis*.—Collected on Chatham Island, lower region, southwest end, by Dr. Baur, June, 1891.

Forma *Carolensis*.—Collected on Charles Island, by Anderson, 1852.

Forma *Barringtonensis*.—Collected on Barrington Island, by Dr. Baur, July, 1891.

Forma *Jervensis*.—Collected on Jervis Island, by Dr. Baur, August, 1891.

[7] I do not give here the description of these varieties, which may be looked up in the original paper.

Var. *Abingdonensis.*—Collected on Abingdon Island, by Dr. Baur, September, 1891. This form is so well marked as to merit varietal rank.

In *Amarantus sclerantoides* Ands. a racial variation has been noted similar to that in *Euphorbia viminea.* The type of the former was collected on Charles Island by Anderson. Two forms collected by Dr. Baur upon Chatham and Hood Islands differ perceptibly in foliage:

Forma *Chathamensis.*—Collected at Chatham Island, lower region, southwest end, June, 1891.

Forma *Hoodensis.*—Collected on Hood Island, July, 1891.

We shall now see what Mr. W. Botting Hemsley,[8] of the Royal Kew Gardens, has to say, who is a specialist in insular floras.

In 1894 the first part of a splendid series of papers appeared in *Science Progress* under the title, "Insular Floras," in which some remarks about the flora of the Galápagos are made. At the end the following sentence occurs:

"Concerning the origin of the fauna and flora of the Galápagos, Agassiz vigorously attacks and ridicules Baur's theory of subsidence, put forward with so much confidence, and briefly stated thus: '*The Galapagos are continental islands, originated through subsidence;* they all formed at a past period one large island, and this island itself was at a still former period in connection with the American continent.'[9] It will be sufficient

[8] Hemsley, W. Botting. Insular Floras. Science Progress, Vol. I, No. 5, July, 1894, p. 400-401.

[9] These words occur in my paper on the "Origin of the Galápagos Islands," April, 1891, p. 307, published before my departure. The sentence which expresses my theory is preceded by the following words: "I started with the sentence that continental islands must have a harmonic flora and fauna. In the Galápagos we found absolute harmony; my conclusion, therefore, is," etc. I have replied to the criticisms made by Prof. Agassiz in his "General Sketch of the Expedition of the Albatross," from February to May, 1891, (Bull. Mus. Comp. Zool., Harvard Col., Vol. XXIII, No. 1, Cambridge, Feb., 1892) in Science, Vol. XIX, No. 477, March 25, 1892, p. 176. From this I quote the following: "Professor Agassiz has completely overlooked the main point of my argument. This I considered the harmony in the distribution of fauna and flora, as will be seen by referring to my paper. I tried to show that this harmony was absolutely unexplainable by the theory of elevation. After this was done, I examined whether our present knowledge of the soundings showed any serious obstacle to

to have directed attention to the discussion here. It is worth adding, however, that Baur's article is supplemented by an excellent bibliography."

On October 24, 1895, Hemsley[10] published a review of Robinson's and Greenman's Flora of the Galápagos Islands.

"Dr. G. Baur's theory of the origin of the Galápagos Islands is too well known to need explanation here; yet, it may be briefly designated the theory of subsidence. He argues that the islands were formerly connected with each other, and at an earlier period with the American continent. It is also almost needless to say that this theory has met with an exceedingly hostile recognition. The publication of an account of the botanical collections (Robinson and Greenman) affords an opportunity of examining this theory from a botanical standpoint. For the purposes of the 'Botany' of the *Challenger* Expedition, and ever since that publication of this work, I have collected all the data coming under my notice bearing on the dispersal of plants to considerable distances by wind, water, birds or other creatures, excepting human. The evidence thus collected sufficiently accounts for the vegetation of low coral islands, and the littoral vegetation of widely separated countries; but it in no way helps to explain the vegetation of the enormously distant islands of the Anarctic seas, for example, or that of the islands of the Galápagos group, to give another instance.

"But these are not parallel cases; they are the two extremes in the amount of differentiation in connection with isolation.

"The biological phenomena of the Galápagos Islands left a deeper impression, probably, on the mind of Darwin than those of any other part of the world he visited, and doubtless had

the theory of subsidence, and I found that it did not. *Professor Agassiz did not refer with one word to this harmony of distribution, which formed the basis of my whole ideas.* When Professor Agassiz, or any one else, is able to explain this by the elevation theory, I shall be the first one to adopt it. But, until this has been done, I believe in subsidence. The paper to which Professor Agassiz refers was written before my visit to the islands. My investigations have only more convinced me of the insufficiency of the elevation theory."

[10] Hemsley, W. Botting. The Flora of the Galápagos Islands. Nature, Vol. 52, No. 1356, October 24, 1895, p. 623.

much to do with his later conception of the origin of species. The fact on which he laid special stress was that the genera, to a very great extent, were the same as in all the islands, and the species different in each island. Dr. Baur's much more extensive zoological and botanical collections and observations confirm and emphasize the correctness of the view of his illustrious predecessor of fifty years ago. Darwin especially refers to the existence of different species or races of tortoises and mocking-thrushes [*Nesomimus*] in many of the islands; and Baur's examination of the lizards of the genus *Tropidurus*, from twelve of the islands, reveals the same condition of things. The botanists bring forward *Euplorbia viminea* in illustration of this phenomenon. This species was described by Sir Joseph Hooker from a single specimen collected by Macrae in Albemarle Island, and the author remarks that he "knew of no species with which to compare this highly curious one." Dr. Baur collected it extensively in eight of the islands, and the specimens from almost every one of them [7] exhibit distinct racial characteristics. *Acalaphe*, a genus of the same natural order, presents somewhat more pronounced variation in the different islands, which some botanists regard as of specific value; other botanists, as of varietal value only. Whatever status we give these forms, the flora as a whole is a most instructive and convincing illustration of evolution.

"A remarkable peculiarity of the Galápagos flora as an insular flora is the almost total absence of endemic genera, for the two or three genera of the Compositæ restricted to the islands are so closely allied to the American genera as hardly to count as distinct. Indeed, the whole flora is so thoroughly American that, apart from geological difficulties, it might be regarded as a differentiated remnant thereof, rather than derived therefrom, after the supposed elevation of the islands. Analogous conditions and phenomena are repeated in the deep valleys of the great mountain chains of northern India and western China, where, in neighboring valleys, the genera are to a great extent the same and the species different.

"Looking at the composition of the Galápagos flora, especially with an eye to the probabilities of the transport of the

seeds of its constituents, combined with present conditions, Dr. Baur's theory seems deserving of more serious consideration than it has hitherto received. My slender knowledge of geology alone prevents me from taking up a more decided position."

The last communication of Hemsley[11] appeared in the June number of *Science Progress*, 1896. He writes: "When reviewing the newer literature relating to the flora of the Galápagos Islands I found little to add to what had been done by Darwin, Hooker and Anderson; merely mentioning the visit of the United States ship *Albatross*, and Dr. Baur's theory of the origin of the fauna and flora. Since then an account of Dr. Baur's botanical collections has been published, and the substance has also appeared in an English journal, and Dr. Baur himself has written and lectured in defense of his theory of the origin of this group of islands. As previously stated, he contends that the evidence points to the present condition being the result of subsidence, that the islands were formerly connected with each other, and at a still earlier period with continental America. Although this theory has been derided, I think the biological data strongly favor its correctness; and the soundings given in the map accompanying Agassiz's report of the *Albatross* expedition show a relatively shallow area in which the Galápagos Islands are situated, and which extends eastward to the mainland of Veragua. Probably the segregation would be greatly anterior to the segregation of the West Indian Islands."

It is seen that the subsidence theory has won very extensive ground, in fact, there are only very few opponents left which in the future might be converted. Besides Agassiz, whom I have mentioned before, Stearns, Dall and Wolff. Dr. Stearns[12] had only seen my paper published in the AMERICAN NATURALIST (March, April, 1891), before my visit to the Galápagos. He believes in the elevation theory and the accidental importation of the fauna and flora by currents.

[11] Hemsley, W. Botting. Insular Floras. Part VI. Science Progress, Vol. V, No. 28, June, 1896, p. 298–302.

[12] Stearns, Robert E. C., Ph. D. Report on the Mollusk-Fauna of the Galápagos Islands, with Descriptions of New Species. Proc. U. S. Nat. Mus., Vol. XVI, p. 353–450, Pl. LI–LII, Washington, 1893.

W. H. Dall,[13] who has written the most extensive work on the landshells of the Galapagos Islands, also adopts the accidental introduction of the fauna. He says, p. 403: " Omitting the *Auriculidæ* and *Siphonariidæ*, we have, as supposed, peculiar forms in each group of islands: twenty-one characteristic of the southeastern, fourteen from the central, and one from the northeastern group of islands, which agree well with the hypothesis that the species originated with forms brought by winds and currents which impinge first on the southeastern group.

On the other hand, it is certain that the southeastern islands are much better known than either of the other groups, and that the area and fertility of the central group are such that there is every reason to suppose many more forms remain to be discovered there, perhaps, including some of those so far known only from the southeastern islands. Prudence strongly urges, that we know too little of the mollusk fauna yet to intelligibly discuss its inter-island distribution."

If the seeds of the different forms of *Euphorbia viminea* Hook. fil. are not blown or floated from one island to the other, as we have seen above, I cannot imagine that the landshells have been transported from island to island, or even from the American continent. Why ought these animals form an exception from the other ones?

Dr. Th. Wolf[14] does not agree at all with the subsidence theory. He says: " Every geologist will stand up against Dr. Baur's hypothesis, until he shall have proved that it is absolutely indispensable for the explanation of the organic creation (organische Schöpfung) of the islands. The answering of the question: How have the present species of animals and plants been developed from the immigrated (or, according to Baur, the remaining) South American[15] species? is very difficult. Here opens, of course, an enormous field for speculation, and, as long as the opinions on the fundamental causes of the origin

[13] Dall, William Heally. Insular Landshell Faunas, Especially as Illustrated by the Data Obtained by Dr. G. Baur in the Galápagos Islands. Introductory. Proc. Acad. Nat. Sci., Philadelphia, August, 1896, p. 395–459, Pl. XV–XVII.

[14] Wolf, Dr. Th. Die Galápagos-Inseln. Verhandl. Ges. Erdkunde. Berlin, Bd. XXII, 1895, No. 4 u. 5. Berlin, 1895, p. 246–265, Taf. 3.

[15] I never said that they came from South America.

of species are so different, as to-day, the attempted explanations will be different. *Non nostrum inter vos tantas componere lites.*"

Mr. Ridgway[16] does not reach a definite conclusion about the origin of the Galápagos, but he says: "If the apparent relationships of the fauna have any bearing on the question, I believe Dr. Baur's theory to be at least worthy of serious consideration."

In regard to the question of relationship of the six peculiar genera of the Galápagos, Ridgway reaches the following conclusion. Only two (*Nesomimus* and *Nesopelia*) are of evident American relationship. The remaining 3 [4] have so obvious a leaning toward certain Hawaiian Dicæidine forms that the possibility of a former land connection, either continuous or by means of intermediate islands as 'stepping stones,' becomes a factor in the problem. It may be that the resemblance of *Cocornis*, '*Cactornis*,' and *Camarhynchus*, to the above-mentioned Hawaiian forms (*Lorioides*, *Telespiza* and *Psittirostra*) is merely a superficial one, and not indicative of real relationship. I do not by any means claim, on the strength of such evidence, a common origin for them, but merely present the facts as 'food for reflection.' *Certhidea* is also compared with Hawaiian genus *Oreomyza*, of the chiefly Polynesian family *Dicæidæ*.

Since there is no relation whatever of the Galápagos fauna and flora as a whole to fauna and flora of the Hawaiian Islands, the similarities between these birds are certainly only superficial. A former connection between the Galápagos and the Hawaiian Islands is entirely out of the question, these two archipelagos are 7350 miles distant from each other, there is not a single island placed between them, and the intervening sea is 4000 meters deep.

For the opponents of the subsidence theory I give now a few striking examples of continental islands.

The *Solomon Islands* are connected by the 2000 m. line with New Guinea and the New Hebrides. The Solomon Islands possess 12 species of Amphibia.[17]

[16] Ridgway, Robert. Birds of the Galápagos Archipelago. Proc. U. S. Nat. Mus., Vol. XIX, p. 465–467. Washington, 1896 [published April 1, 1897].

[17] Boulenger, G. A. On the Reptiles and Batrachians of the Solomon Islands. Trans. Zool. Soc. London, Vol. XII, part I, April, 1886, p. 47–62, pl. VIII–XIII. Second Contribution to the Herpetology of the Solomon Islands. Proc. Zool. Soc., 1887, II, p. 333–338.

The family *Ceratobatrachidæ* Boulenger with *Ceratobatrachus günteri* Boul. is only found there. The other species are:

Ranidæ.

Rana bufoniformis Boul., nearest to *Rana kuhlii* (Schleg.) Dum. and Bibr. from the Indian Archipelago (Java, Borneo, Celebes), S. China.

Rana guppyi Boul., as large as the bull-frog, nearest to *Rana gruniens* Daud., Amboyna and Java.

Rana opisthodon Boul., near *R. guppyi* Boul. and *R. gruniens* Daud. This form develops in the egg without metamorphosis, like *Hylodes martinicensis* Tschudi.

Rana krefftii Boul., related to *R. erytraea* Schleg., from the East Indian Archipelago and the Malayan Peninsula.

Cornufer dorsalis A. Dum., also found on the Fiji Islands.

Cornufer guppyi Boul., related to *C. dorsalis* A. Dum.

Cornufer solomonis Boul., near *C. corrugatus* A. Dum., from New Guinea and Duke of York I.

Batrachylodes vertebralis Boul., only known from the Solomon Islands.

Hylidæ.

Hyla macropus Boul.

Hyla thesaurensis Peters.

Hyla lutea Boul.

The presence of this peculiar Batrachian fauna on the Solomon Islands would be sufficient proof for their continental origin, but this is also shown by the geology of the group.[18]

[18] Guppy, H. B. The Solomon Islands, their Geology, General Features and Suitability for Colonization. London, 1887.

There have been found granitoid porphyrites, serpentines and old sedimentary rocks represented by quartzites and crystalline schists.

New Caledonia is surrounded by a deep sea of 2000–4000 m., but it is a typical continental island, as is shown by the geology.[19] There are extensive primitive schists, gneiss and other

[19] Bernard, Augustin. L'Archipel de la Nouvelle-Calédonie. Paris. Hachette et Cie, 1895, p. XXIV, 458. Deux cartes et beaucoup de figures. This is a very important work, not only for the geology of New Caledonia, but for the whole western region of the Pacific Ocean.

crystalline rocks, and the Triassic and Cretaceous cover extensive areas.

The *Fiji Islands* are even more isolated, being surrounded by a sea of 2000–4000 m. South of this group the soundings show 4000–6000 m.,and east from the Tonga Islands even 6000–8000 m. But on the Fiji Islands we find three species of frogs: *Cornufer dorsalis* A. Dum., only known from the Solomon Islands, besides two peculiar species, *Cornufer vitianus* A. Dum. and *C. unilineatus* Peters.

The genus *Cornufer* Tschudi shows the following interesting distribution (Boulenger: Catalogue Batrachia Salientia s. Ecaudata, London, 1887, p. 107–111).

1. *Cornufer unicolor* Tschudi. New Guinea.
2. *Cornufer guentheri* Boul. Philippines.
3. *Cornufer mayeri* Günth. Philippines.
4. *Cornufer jagorii* Peters. Samar Island.
5. *Cornufer corrugatus* A. Dum. Philippines, New Guinea, Duke of York Island.
6. *Cornufer punctatus* Peters & Doria. New Guinea.
7. *Cornufer guppyi* Boul. Solomon Islands.
8. *Cornufur solomonis* Boul. Solomon Islands.
9. *Cornufer dorsalis* A. Dum. Solomon and Fiji Islands.
10. *Cornufer vitianus* A. Dum. Fiji Islands.
11. *Cornufer unilineatus* Peters. Great Viti Island (Fiji I.).

A still more peculiar fact is the presence of a very large Iguanoid Lizard *Brachylophus fasciatus* (Brongn.), also found on the Friendly Islands. The nearest relatives of *Brachylophus* Cuv. are *Conolophus* Fitz. and *Amblyrhynchus* Bell from the Galapagos; *Iguana* Laur., Tropical America; *Metopoceras* Wagler, San Domingo; *Cyclura* Harlan,West Indies (Cuba, Jamaica, Bahamas); and *Ctenosaura* Wiegm., Central America.

Of the 50 genera of *Iguanidæ* 47, with over 300 species, are American; two genera, *Chalarodon* Peters, with a single species, and *Hoplurus* Cuv., with three species, are found in Madagascar. This is certainly a very interesting case of distribution.

The genus *Enygrus* Wagler, a snake of the family *Boidæ* (Subfamily *Boinæ*) is represented by four species, which show the following distribution:[20]

[20] Boulenger, George Albert. Catalogue of the Snakes in the British Museum. (Nat. Hist.) Vol. I, p. 104–109, 1893.

1. *Enygrus bibronii* Hombr. & Jacq. Fiji, Friendly or Tonga and Solomon Islands (San Cristoval).

2. *Enygrus australis* Montrouzier. New Britain, Solomon Islands, New Hebrides, Loyality Islands, Samoa.

3. *Enygrus carinatus* Schneid. Pelew Islands, Ternate, Ceram, Amboyna, Timor Laut, Misol, New Guinea, Louisiade Archipelago, Duke of York Island, Solomon Islands.

4. *Enygrus asper* Günth. Misol, Salavatti, New Guinea, and Duke of York Island.

The presence of *Cornufer, Brachylophus* and *Enygrus* can only be explained by the continental origin of the Fiji Islands. Here, also, the geological proof has been given.[21]

In 1862 and 1865 the Fiji Islands were visited by Graeffe, and from 1876–78 by Th. Kleinschmidt, sent there by the Museum Godeffroy in Hamburg. Gräffe collected rocks on Viti Levu and on some small islands belonging to the Exploring Islands; Kleinschmidt on Viti Levu, Kandavu, Ono, Vatu Lele and Ovalau. The material has been worked up by Arthur Wichmann.[22]

The most important result reached by the examination of the Kleinschmidt-collection consists in the demonstration of the existence on the Fiji Islands (Viti Levu) of old crystalline massive rocks and crystalline schists in considerable extension. The following rocks belonging to the chrystalline schists have been found: Amphibolites, Eurites, Quartz-mika-schists, granular Limestone. Of the most important older massive rocks occur Granite, Quartz Porphyry, Diorite, Gabbro, Diabase, Foyaite, and a Sandstone similar to Itacolumit. These rocks have been found partially *in situ,* partially they have been picked up from the beds of different brooks and rivers. No trace of paleozoic and mesozoic strata have been discovered. The youngest massive rocks are represented only by Andesites and Basalts, the former very much more developed. Their

[21] I have reached the conclusion about the continental origin of the Fiji Islands before I knew of the geological proof by Wichmann. This paper I saw for the first time in June of this year in the Crerar Library.

[22] Wichmann, Arthur. Ein Beitrag zür Petrographie des Viti-Archipels. Mineralog. und Petragraph. Mittheilungen: herausgeg. von G. Tschermak. (Neue Folge) 5. Band Wien, 1883, p. 1–60.

tuffs and conglomerates are often fossiliferous, and form the superficial cover. These fossils are of Tertiary age, and certainly not older than Miocene. Of minerals: gold, copper, quartz, pyrite, hæmatite and others were found. All the other islands visited by Kleinschmidt, Kandavu, Ovalau, Ono, Vatu Lele and the Munia, Kanathia, Vanuna-Bulavu of the Exploring Islands, on which Gräffe collected, consist nearly entirely of Andesites and Basalts and their tuffs. In some, for instance, Ono, Vatu Lele, coral-rocks and silicified corals occur.

If we compare the results found on the Fiji Islands with the geological conditions of other islands of the Pacific Ocean, we partly observe very surprising similarity. A very short time ago it was considered as certain, and generally accepted, that all islands of the Pacific Ocean originated through volcanic activity. As exceptions were named New Zealand and New Caledonia. The investigations of the last years have brought forward more light about several of these conditions. Drasche, in 1879 (Neues Jahrb. Min. Geol., 1879, p. 265), stated that only those groups of islands placed eastwards from a line extending from Kamtschatka over Japan, the Philippines, New Guinea, New Caledonia, New Zealand, Auckland, Macquarie to Arctic Victoria, are either coral islands, or consist of young volcanic rocks.

Outside of this line there are, besides the Fiji Islands, some other groups. From the *Pelew Islands* Wichmann described large blocks of a very coarse-grained hornblende-granite and diabase, found at the seashore and at elevations of 400 m. [Journal des Museum Godeffroy, 1875, VIII, p. 126.] Marcou has reported granite and gneiss from the *Marquesas Islands*, and Eichwald[23] has shown that the Aleutian Islands contain Cretaceous strata.

Wichmann makes the following remarks at the end of his paper: "No older massive rocks or sedimentary strata are known from the other "volcanic" groups of islands of the Pacific Ocean, and on some of these, for example, the Galápapos or Sandwich Islands, it seems really to be made out that

[23] Eichwald, E. Geognostisch-palæntologische Bemerkungen über die Halbinsel Magischlak und die Aleutischen Inseln. St. Petersburg, 1871.

they have been built up by younger and recent volcanic masses. There is a possibility, and even probability, however, that older formations served as fundament, the examination of which is prevented by the extensive covering."

From the facts mentioned, it follows that these islands in the Pacific, which, so far as known, are merely of volcanic origin, are not of much significance. Besides, various extensive regions have been terra firma during long periods. On the groups of islands which extend from the Philippines to the Fiji Islands, all marine sediments are missing up to the upper Cretaceous (New Britain), on the others even up to the Miocene. It is remarkable that the northern islands (Japan) and the southern (New Zealand) show the different formations very much more developed. A complete representation of the strata is not found in a single group of islands, therefore, we can suppose that they, together with portions of the ocean, formerly represented continental masses. Thus, it becomes probable, that the Pacific Ocean cannot be considered of great age, that it received approximately its present form only during the time of the younger Tertiary (Wichmann).

From the peculiar fauna of the Fiji Islands we reached the conclusion that they must be of continental origin. The correctness of this conclusion follows from Wichmann's petrographical studies of the rocks.[24]

For the Galápagos Islands the correct geological proof cannot be given, but the harmonic distribution of fauna and flora can only be explained by their continental origin. The connection must have been with Central America and the West Indies over Cocos Island. There are no geological difficulties, since we know that the Fiji Islands, which are surrounded by much deeper sea, are continental.

It is evident that the theory of the consistency of continents and oceans since palæozoic times, or ever before, must be abandoned completely. Edward Suess,[25] in his masterly

[24] Only by this theory many very peculiar cases of distribution in the Pacific Region and the presence of Pacific and Asiatic forms on the coast of America can be explained.

[25] Suess, Eduard. Das Antlitz der Erde. 2. Bände Wien, 1885–88. Band I. Zweite unveränderte Auflage Wien, 1892.

work, "Das Antlitz der Erde," has fully demonstrated the fallacy of this theory. If Dr. Alfred Russel Wallace[26] would have studied this work and those of W. T. Blanford, O. Feistmantel, W. Waagen, Melchior Neumayer, and others, he could not have accepted the theory of the permanence of the great oceanic basins, which he still defends in 1892, quoting the late Prof. Dana, Mr. Darwin, Sir Archibald Geikie, Dr. John Murray, Rev. O. Fisher and himself as authorities, not mentioning any of the names just given.

We know now that there existed a *Lemuria* or *Gondwana Land*, an *Antarctic Continent*,[27] which extended to India, South Africa, South America, and that the Pacific Ocean has not been an ocean since palæozoic or archæan times, but is probably even of recent (Tertiary) date.

In order to reach correct conclusions about these often very complicated questions, it is necessary to use all the data offered by modern geographical and palæontological distribution of fauna and of flora geology.

(*To be Continued.*)

ON THE AFFINITIES OF TARSIUS: A CONTRIBUTION TO THE PHYLOGENY OF THE PRIMATES.

By Charles Earle.

(*Continued from page 575.*)

The female reproductive system of the Lemurs recalls that of the Anthropoids. It is interesting to note that in *Lemur Propithecus* and *Indris* only one young is produced at a birth; whether this number of young is typical of the whole suborder

[26] Wallace, Dr. A. Russel. The Permanence of the Great Oceanic Basins. Nat. Science, Vol. I, No. 6, August, 1892, p. 418–426; and "Island Life," second ed., 1892.

[27] Seward, A. C. The Glossopteris Flora. Science Progress, New Series, Vol. I, No. 2, January, 1897, p. 178–201. (This paper gives the Bibliography relating to the Anarctic continent.)

of *Lemuroidea* I am unable to discover. The form of the uterus exhibits considerable variation in the Lemurs. Milne-Edwards says: "L'Uterus des Indrisines a la forme d'une poche median dont le fond est bicorne les deux lobes ainsı constitués sont tres peu saillants chez les Propithiques et les Avahis, ils le sont davantage chez l'Indris." In *Propithecus* especially, the cornua are extremely reduced, and externally the uterus has the appearance of the uterus simplex of the Anthropoids. In the gravid uterus, owing to the extremely small size of the cornua, the single fœtus occupies one horn and all the body of the uterus; in *Lemur* the non-gravid cornua is occupied as shown by Turner by a prolongation of the chorion. It is not difficult to imagine the derivation of the uterus of the Apes from the condition found in the higher Lemurs, further constriction of the fallopian tubes of *Propithecus* and obliteration of the slight septum dividing the rudimentary cornua of this genus would produce the pure type of uterus simplex found in the Apes.

I will now pass on to consider the palæontological history of the Primates and the conclusion which may be drawn from it. Prof. Hubrecht claims that throughout the whole Tertiary period the Lemurs and Apes were perfectly distinct, and, moreover, he concludes that we must go as far back as the Mesozoic to find the two stem forms of these suborders. I hold there is absolutely no palæontological evidence to support this deduction, and all our knowledge of the fossil Primates show that the Apes have arisen later than the Lemurs. Prof. Hubrecht, following Ameghino, refers the Santa Cruz formation, in which *Homunculus* occurs, to the Eocene. All palæontologists now admit that the Santa Cruz beds are of much later date than the Eocene, and it appears probable that they are not earlier than the Lower Miocene. If there is anything in the biological law that less specialized forms originate earlier than the more modernized types, it is surely applicable to the Primates where every one must acknowledge that an Ape is a much more highly differentiated organism than a Lemur.

I will not consider the so-called Primates from the lowermost Eocene, Puerco. We know little about these forms, but, as far as our knowledge goes, such genera as *Indrodon* and

Mixodectes appear to be related to the Lemurs, but in the case of *Indrodon* the shape of the external cusps of the superior molars are not at all *lemurine*, and resemble more those of the *Cheiroptera*.

The Wasatch genus, *Anaptomorphus*, has been placed by Hubrecht with Tarsius, among the Apes and for what reason? It certainly has only one Anthropoid character, the presence of an internal lobe to the third upper premolar. If *Anaptomorphus* is an Ape, then I claim that this is absolute evidence that the Apes have come from the Lemurs, for *Anaptomorphus* is in all of its characters a Lemur closely related to *Tarsius*. However, *Anaptomorphus* is an important type in connection with the phylogeny of some of the Anthropoids, and may have given origin to the American Monkeys, these latter having arisen independently from the Old World Apes. Numerous peculiarities in the structure of the *Cebidæ* as compared with the *Cercopithecidæ* support this view. Excepting *Anaptomorphus* it appears probable that none of American fossil lemurines can be considered as ancestral to either the recent Lemurs or Apes.

In the Oligocene of France the primitive Lemurs were very abundant, and they were represented by numerous genera other than the well-known *Adapis* and *Microchoerus*. Consequently, as far as we know, the recent Lemurs must have been derived from some of the genera now found as fossils in Northern Europe. Mr. Lydekker is of the opinion that Apes occur in the Oligocene of France, but I have not been able to find any evidence for this view, as most of the supposed Apes from the Phosphorites have been shown to be Suillines. The structure of the upper molars of *Adapis* is very similar to that of recent Lemurs, the external lobes being lenticular in section as in recent forms, the protocone is placed well forward and the hypocone is more primitive than in many of the *Lemurinæ*. As far as I have examined, all recent genera of the subfamily *Lemurinæ* have tritubercular superior molars with varying development of the supplementary internal cusps. In the *Indrisinæ* the molars are truly quadritubercular and the internal cusps are nearly selenoid in structure. It is strange that among American Monkeys, *Mycetes* has a type of superior molar which

closely resembles that of the *Indrisinæ*, whereas, in the other *Cebidæ*, the upper back teeth are transitional in structure, between the tri- and quadritubercular types, and the cusps are bunoid. The molar pattern of recent Lemurs and Old World Apes is fundamentally different, but they may be brought into closer relations by means of the primitive structure of the molars of *Tarsius* or *Anaptomorphus*. If *Tarsius* stands near the common ancestor of both Apes and Lemurs, then we must suppose that the teeth of the two phyla of recent Primates have increased in complexity during geological time. Nevertheless, in the Anthropoid Apes the molar pattern shows plainly a process of degeneration from a higher type, more like that found in the *Cercopithecidæ*.

Until recently no known Primate, fossil or recent, possessed a closed orbit as in the Apes and proclivous incisors and caniniform first lower premolar as in the Lemurs. This combination of characters is found in the Malagasy fossil lately described by Forsyth Major under the name of *Nesopithecus*. The skull, as far as known in *Nesopithecus*, is broad and short like that of the Apes, and as in the latter group the lachrymal foramen is within the orbit. Again, the structure of the true molars is exactly like that of the Anthropoids. On the other hand the form of the premolars is more like that of the Lemurs, and, as far as I can learn from Major's figures, all the upper premolars have small internal lobes. The incisors of *Nesopithecus* are not preserved, but from the oblique position of their alveolii Major concludes that these teeth must have been horizontal as in the living Lemurs. Moreover, as in the latter group, the first lower premolar functions as a canine. The collection of characters occurring in *Nesopithecus* completely breaks down the differential characters of the skeleton which is usually given as separating the Lemurs from the Apes. Either these two groups should be united, or *Nesopithecus* must be placed in a new suborder of the Primates. It remains now to consider whether *Nesopithecus* clears up the problem of the relation of the Lemurs to the Apes. Lydekker is of the opinion that *Nesopithecus* is a form closely related to the stem type which gave origin to both Lemurs and Apes. For my part, I

do not think that this explanation is probable, and for the reason that no primitive ancestor of the Primates would have had a closed orbit and proclivous lower incisors. At the time the Apes and Lemurs diverged from a common stock, this stem form would have had characters more like those of the *Adapis*, and not until very late, geologically speaking, were the peculiar incisors of the Lemurs developed. Primates with closed orbits do not appear until the Middle Miocene. We are then forced to the conclusion that one set of characters of *Nesopithecus* is due to convergence. As *Nesopithecus* has so many peculiar characters only found in the Anthropoids, including the structure of the true molars, I conclude with Major that *Nesopithecus* is really an Anthropoid whose anterior dentition through convergence has come to resemble that of the Lemurs. Lastly I do hold that the discovery of *Nesopithecus* demonstrates that Apes and Lemurs are genetically related.

The characters of the skeleton of *Tarsius* are nearly all those of the Lemurs; the extreme specialization of the pes of *Tarsius* is clearly a lemurine character, and we can observe how this elongation of the tarsus is produced. In *Lepidolemur* the elongation of the calcaneum and navicular commences, the extension of these bones is carried still further in *Cheirogaleus*, and reaches its culmination in *Tarsius*. Of course this is not a phyletic series, and I merely mention it to show how the elongation of the tarsus in *Tarsius* is developed, and from a more normal condition found in the typical Lemurs. *Tarsius* differs from most of the Lemuroidea in not having the fourth digit of the manus longer than the others, the extension of this digit attains its greatest development in the most specialized group of the Lemurs, the *Indrisinæ*. The Indrisines are clearly the most highly differentiated division of the Lemurs; this is shown in their more highly developed brains, reduction in the length of the facial as compared to the cranial axis of the skull, the pseudo-selenoid superior molars, and lastly the great length of the posterior limbs in contrast with the anterior members. In this connection it is interesting to note that the *Indrisines* are diurnal in their habits like most Apes, and that in *Indris* the caudal appendage is much reduced in size.

Forbes pointed out the important fact that the structure of the orbit in the Old and New World Apes differs; in most of the *Cebidæ* there is a large articulation between the malar and parietal, the broad plate-like alisphenoid is limited to the inferior portion. In the *Cercopithecidæ* the alisphenoid is narrow and prolonged above to the frontal, so as to separate the malar-parietal contact. In the structure of its orbis *Tarsius* more resembles the Old World Apes, for the alisphenoid articulates with both malar and frontal as in the *Cercopithecidæ.* The structure of the skull of *Tarsius* is of importance as showing how the closure of the orbit of the Apes is brought about. It is evident that the relations of the orbital bones found in the *Cebidæ* is the primitive one, the broad and inferiorly placed alisphenoid is characteristic of the lower orders of Mammals, as the Rodents and Carniverous Marsupials. Coincident with the increase in breadth of the frontal lobes of the cerebrum of *Tarsius* as compared to other Lemurs, has taken place a reduction of the facial portion of the skull, and with it the near approach of the lachrymal foramen to the orbital border. *Nesopithecus* represents another step in the evolution of the skull of the Apes from that of the Lemurs, as in this form the facial axis is still more reduced, and at the same time the lachrymal foramen has been taken within the orbit. In *Nesopithecus* the orbits are directed forwards as in the Apes, and Forsyth Major concludes from the broken condition of the posterior orbital wall, that this genus had a completely closed orbit. The skull of *Tarsius* represents a stage in the evolution of the Primate cranium exactly intermediate between that of the Apes and Lemurs. Among the typical Lemurs the general form of the cranium in the *Indrisinæ* is closely similar to that of *Tarsius.*

Although the structure of the molars in *Tarsius* is very primitive, and may represent the ancestral pattern from which that of the Lemurs and Apes has been derived, this cannot be claimed for the anterior part of the dentition. The reduction in size of the canines in *Tarsius* and the enlarged upper median incisors is certainly a case of specialization. We see this same change in the *Insectivora,* and Flower concludes: "The strongly marked distinction of the canines from the incisors

and anterior premolars in the Mesozoic and most of the Tertiary Mammals (excepting some Ungulates) points, however, very decidedly to the conclusion that the want of definition between these teeth in many of the modern *Insectivora* is an acquired feature." I quote this passage from Flower and Lydekker, because an important paper by Leche has lately appeared in which he claims that the milk teeth represent an earlier development phase than the permanent teeth. He arrives at this generalization from a study of the milk dentition of the Lemurs, including *Tarsius*. Leche finds, for example, that in the anterior milk dentition of *Adapis magnus* the milk canines are much reduced in size, and more resemble the form of the premolars, and he also points out that the deciduous dentition of this species of *Adapis* very closely resembles the permanent condition of *Adapis parisiensis*. Leche concludes, therefore, that *A. parisiensis* represents the most primitive and ancestral form of *Adapis* known, and that the Ape-like form of the incisors and canines of *A. magnus* is a secondary condition derived from that of *Adapis parisiensis*. I feel confident that palæontologists will not accept this dictum in regard to the significance of the milk dentition as expounded by Leche. I should like to notice one point that seems to contradict this general law as deduced by Leche. In *Tarsius*, for example, Leche's figures plainly show that the upper milk canine is larger than either of the milk incisors or the anterior premolars. If the structure of the anterior milk teeth is to be our guide in determining the evolution of the Lemurs, then *Tarsius* has come from a type which had large canines and in which these teeth were erect and of greater size than either the incisors or premolars. This conclusion corresponds better with the palæontological record.

One of the best examples of extreme specialization and reduction in the size of the canines is the case of the *Anoplotheridæ*, an extinct family of Artiodactyle Ungulates. In this group the dentition is closed and the canines are of the same size and structure as the anterior premolars. I am sure that no palæontologists will claim that the dentition of the *Anoplotheridæ* is primitive, as the whole structure of this family de-

notes that it is an exceedingly specialized group. I have endeavored to show elsewhere that *Tapirulus* is probably genetically related to the Anoplotheroids, and in this genus the canines are fully developed. As far as I can learn it is a general character of the milk dentition that the milk canines are weakly developed and much smaller than their permanent successors. It appears more likely that the milk dentition represents a special adaption during the time that the young animal is nourished by the mammary glands of the mother, and that the detailed structure of the milk teeth do not accurately recapitulate the ancestral stages in the evolution of the race. However, in regard to the number of the milk teeth, that is another question, for we know that in many types which in the adult condition the permanent teeth are greatly reduced in number, whereas in the milk series the lost teeth appear. Among Lemurs *Cheiromys* is a good example in the reduction of the teeth, where the milk dentition is more normal in regard to the number of teeth than the permanent dentition, and plainly shows that *Cheiromys* has been derived from some more generalized type of Lemur, which had the normal number of incisors and premolars.

In conclusion, the two principal objections in claiming that the Lemurs are genetically related to the Apes are, first, in the apparently great difference in their placentation, and secondly, in the wide divergence in the structure of their dentition. In regard to the evolution of the placenta, Dr. Minot remarks that our conceptions are still very obscure. The views of Balfour which I have lately quoted[2] as to placental evolution in the Primates are clearly untenable, for the reason, as I have

[2] See Natural Science, May 1897.

emphasized before, that in the Apes the allantois is rudimentary and the placenta arises in the chorion. It is most important for the position which I maintain in regard to the relations of the Lemurs to the Apes, to notice that in the early stages of the development of the placenta in the Anthropoids that this organ is completely diffuse and there is no decidua. This stage is comparable to the diffuse placentation of the Lemurs. On any theory of the evolution of the placenta in

the Primates we must first commence with the non-deciduate diffuse condition as found in Man, the later restriction of the placental area brings about complications in the relations of the maternal to the fœtal surfaces, resulting in the formation of a decidua. Hubrecht himself admits that *Tarsius* is very specialized in not exhibiting in its early stages the diffuse condition of the placenta found in the Anthropoids. It seems to me that it is a most difficult problem to attempt to derive the type of placentation of the Apes from that of *Erinaceus.* In the latter genus the placenta is derived from the allantois, which is a large free organ before it unites with the chorion. Then, again, in *Erinaceus* there is no early stage where the mesoblast lines the whole blastocyst as in *Tarsius,* and a portion of which membrane takes a share in the formation of the placental anlage. The *Insectivora,* however primitive they are in many respects, are greatly specialized in their dentition and placentation.

Huxley remarks: " If *Gymnura* possessed a diffuse placentation, it would be an excellent representative of an undifferentiated Eutherian." Again, he says: " The derivation of all Eutheria from animals which, except for their placentation, would be insectiverous, is a simple deduction from the law of evolution." That some *Insectivora* are highly degenerate in their cranial and dental structures, I think must be admitted. I refer particularly to *Hemicentetes,* whose supposed primitive type of molars is clearly a case of degeneration from the more normal form of tooth occurring in *Centetes.*

Until it is disproved by further investigations on the early stages of Lemurs, I think it is most plausible to assume that the diffuse placenta of the Lemuroidea is one of the ancestral stages in the evolution of the Anthropoid placentation, and in the case of Man this diffuse non-deciduate stage is recapitulated in the ontogeny of *Homo.*

As far as the palæontological evidence goes it is decidedly in favor of the view that Apes and Lemurs are closely related. Beginning with the earliest known Lemur, *Anaptomorphus,* this genus shows tendencies towards the Anthropoids, and when we pass up into the Oligocene of the Old World, *Adapis* is a

decidedly mixed type, and probably not far from the common stem form, which gave origin to both suborders of the Primates.

In regard to *Tarsius*, it is evidently a type nearly between the Lemurs and Apes, but with many essential characters belonging to the former group. Some of its Anthropoid characters are nascent, so to speak; they are just developing, and, as in the case of the orbit of *Tarsius*, it is not yet fully differentiated into the higher type of the true Anthropoids. It appears most likely that the group of fossil Lemurs with reduced canines and enlarged incisors, *Mixodectes, Microchœrus,* were not in the line leading to the Lemurs proper, but may have been related to *Cheiromys.* These genera in their turn arose out of a generalized insectiverous-like type with a normal dentition, which was also the ancestral form of the true Lemurs. The Anthropoids diverged from a lemurine stock probably not earlier than the Upper Eocene. This deduction is supported by the fact that the first Lemurs to appear are insectivorous in their affinities; later, in the Upper Eocene, Lemurs are found with quite Ape-like skulls and dentition, and, moreover, not until the Miocene do true Anthropoids appear.

I shall conclude this paper with a quotation from a Memoir of Sir Wm. Turner's, whose extensive investigations on the placentation of Mammals are well known to all morphologists: "In the case of the Lemurs it will, I think, be considered by most zoologists that the characters of the teeth, the general configuration of the skeleton, the unguiculate digits, the hand-like form of the distal part of the extremities, the presence of a calcarine fissure in the cerebrum and the pectoral position of at least two of the mammæ, are characters which indicate that the Lemurs have much closer affinity with those mammalian orders with which it has been customary to associate them, than with the Perissodactyla, Suina and Cetacea. Collectively, these characters ought, I think, to be regarded as more valuable indications of structural affinity than should the presence in the Lemurs of a non-deciduate diffused placenta with a large allantois be regarded as indications of structural dissimilarity from the Apes and Insectivora, though the placenta in the latter is deciduate and discoid and the allantois aborted."

THE SWAMPS OF OSWEGO COUNTY, N. Y., AND THEIR FLORA.

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POSITION OF OSWEGO COUNTY.

Oswego County lies in the extreme northeastern corner of the Finger Lake Basin of central New York. Lake Ontario makes, at this point, a great bend to the north after having its shore line almost due east and west for upwards of one hundred and fifty miles. The lake consequently forms the northern and a large part of the western boundary of the county. On the northeast are the foot-hills of the Adirondacks, some of which extend into the corner of the county. On the southeast is Oneida Lake and Oneida River, which occupy the lowest part of the general basin toward its eastern end, and south of which lie the hills forming the divide between this and the Susquehanna Basin. On the southwest there are no physical boundaries separating this county from adjoining ones. The county is part of the plain which extends west and southwest through several counties, the lowest points in which are occupied by Onondaga Lake, Seneca River, the Montezuma Marshes and Cayuga Lake. The plain narrows rather abruptly to the southeast and leads over a very low divide into the valley of the Mohawk River. A comparatively narrow plain follows the lake shore north through Jefferson County.

DRAINAGE SYSTEM OF THE COUNTY.

The present drainage of Oswego County is peculiar. Oswego River, flowing as it does directly through the county, would naturally be expected to receive a considerable amount of the drainage. It, however, receives very little. A low divide extends from east to west through the central and western parts of the county, the summit of which is about halfway between the north shore of Oneida Lake and the south shore of Lake Ontario. The summit of this divide is well-

marked east of the river and extends through Fulton and Palermo center. South of the divide the country is very level, only occasionally relieved by gentle undulations. The streams here are very sluggish and often very crooked, some of them flowing through extensive swamps, as, for instance, the Peter Scott swamp in the town of Schroeppel, which in extent rivals the celebrated Cicero swamps in Onondaga County.

North of the divide the surface of the country is very different. Parallel ridges separated by narrow valleys constitute the distinctive features of the topography of the region. The ridges, and more especially the valleys, have their longitudinal axes at right angles to the shore of the lake and nearly parallel with the river. To the ridges local names are applied as "Paddy Ridge" where an Irish settlement occurs, "Ridge Road" and "The Hog Back," the last name being applied to at least two ridges in different parts of the county. The streams of this northern slope follow the valleys between the ridges and consequently flow into the lake rather than into the river. Black Creek, the only stream of any size that empties into the river from the east is deflected at one part of its course several miles before it finds a break between the ridges through which to flow. The ridges, technically known to geologists as drumlins, are not continuous for any considerable distance, the longest being sometimes several miles, the shorter often being less than a mile; they are, as a usual thing, terminated much more abruptly at their northern than at their southern end. Good examples of the abrupt termination is afforded at Seneca Hill where the river passes so near the hill as to cut away a portion and form a bluff. Another striking example occurs at the northern terminus of Jackson Hill, about three miles north of the village of Fulton. Their southern end usually flattens out gradually, and may be entirely lost in the confluence of several hills.

THE SWAMPS AND LAKES.

The furrowed character of the northern slope just described afforded exceptional opportunities for the formation of lakes and swamps. The underlying drift of the whole region is a

blue hardpan, very impervious to water, and we may suppose that as the water in post-glacial times receded, every depression was left full of water. Many were shallow and were soon filled to the brim with vegetable mould; others were deeper and are even now barely full, while some still contain lakes which the invading plant-life is constantly making smaller. There are presented here all gradations between wooded swamps and open lakes. Some swamps, now mostly wooded, as for example, the Wine Creek swamp near Oswego, still have sphagnum persisting in them, and are, no doubt, lakes filled only at a comparatively recent date, while the vegetable accumulations are so shallow in other wooded swamps as to lead one to believe that the ponds which originally occupied them were relatively soon displaced.

Not only does the contour of the country in the northern part of the county determine the flow of the streams, but it likewise determines the form of the lakes and swamps. They are, so far as I am aware, always elongated in a northerly and southerly direction, some of them being several miles long and less than a mile wide.

TYPICAL SWAMPS.

I have selected three swamps from the score or more within the limits of the county, not because they illustrate better than others the observations to be recorded, but rather because they illustrate swamps in different stages of maturity. I have already hinted at what is meant by the maturity of a swamp. The wooded swamps with shallow accumulations of vegetable material, sometimes called muck, matured early in the post-glacial history of the region. Some are just coming to maturity, examples of which have already been cited, and there are still others which are maturing, but will still require many years for their completion.

For want of a better term I have used the word swamp in an extended sense to indicate the whole depression, whether it be covered with water, woods or moor.

MUD LAKE.

Mud Lake is situated in the southwestern corner of the town of Oswego. It is about eight miles southwest of Oswego City,

and perhaps four miles from the shore of Lake Ontario. The depression in which it lies is one of the largest in the northern part of the county, as indeed, the lake is one of the largest of the numerous small lakes in that section. It is about a mile long by somewhat less than three-fourths of a mile wide. The lake lies in a region where the fluted character is not so pronounced as it is in some other sections, nevertheless the lake itself is elongated in a northerly and southerly direction, and the whole depression of which the lake forms but a small fraction is more than twice as long as wide. This lake has withstood the encroachment of the land-making forces better than many of the lakes in the country, probably on account of its greater depth, yet, if the testimony of old residents is to be trusted, and in this respect at least I have no doubt it is, the surrounding moor is encroaching upon the lake very fast. The moor surrounding the lake is the most extensive one in that section.

THE LILY MARSH.

The swamp known by this name is better known to the people living in that vicinity than other moors as large, or even larger, and probably for two reasons. One is that for many years it has been a famous hunting ground for white rabbits in winter; the other is because a highway was constructed many years ago directly across the open part of the swamp, the open, softer portion being bridged with a long plank bridge. Few people in that part of the county but have had occasion to drive across it, an experience not soon forgotten, at least by a timid person. The Lily Marsh is situated in the southwestern corner of the town of New Haven. It presents the phenomena of a lake just disappearing. The lake in the center is reduced to a mere pool not more than twenty rods long and half as many wide. I have had very definite statements from men who could remember well when the bridge was built, and they assured me that at that time the lake reached to the bridge; now it does not reach within fifteen rods of it. Notwithstanding the fact that the lake in the Lily Marsh is almost overgrown, the swamp itself is a very extensive one. The whole depression in which it lies is very long and narrow. I did not

attempt to get actual measurements of its length and width. From what I could see in it and from the highway I should judge it to be not far from four miles long, and in no place more than three-quarters of a mile wide. In this, as in the other swamps which are nearly mature, the wooded belt covers by far the greater portion of the marsh. There is left here, however, an open bog nearly, if not quite, a mile long, and from twenty to thirty rods wide.

GRANNY'S ORCHARD.

This is the last of the three depressions selected for illustration. It is a marsh in which there is no lake, nor has there been one in the memory of the persons living thereabouts. It takes its name through the resemblance the open portion of it bears to an orchard and a well-confirmed story that a man known universally in those parts as "Granny" attempted at one time to reclaim some of this land by draining it. It is in the eastern part of the town of Palermo, and lies well up toward the divide between Oneida Lake and Lake Ontario. There are more large swamps in this vicinity than in any other part of the county. To these some of the residents apply indiscriminately the term Granny's Orchard, but I feel sure the name originated in the manner I have described, and is restricted by a majority of the people to this single swamp. Yet the appropriateness of the name might easily lead to its more general use.

It is a very extensive swamp. In fact it must be confessed that we had hard work to estimate distance in this place, the view was so intercepted by trees and shrubs. The open portion of the swamp is surrounded by a densely wooded belt, and shrubs and trees of the most aggressive species have invaded the moor until it presents the appearance of an orchard, the trees of which are here represented by tamaracs and spruce. The level openings between are carpeted with sphagnum. The extent and nature of the wooded belt repels visitors even in summer, so that it is seldom visited except by adventurous huckleberry gatherers in August. The man who guided me into the bog, the first time I visited it (himself an old resident),

thought it would be unsafe to venture in there in spring or autumn. To the north of Granny's Orchard proper the wooded belt stretches away for several miles. Catfish Creek, a small stream, flows through the northern end of the swamp, flowing north into Lake Ontario. The small, sluggish stream draining Granny's Orchard flows south into Oneida Lake. It is evident that the whole swamp was once a large lake, and whether it drained into Lake Ontario or Oneida Lake remains to be investigated. The gulf cut through the whole hill where Catfish Creek leaves the swamp suggests that it may have been cut through after the lake had partially filled. I have not yet had an opportunity to study the outlet to the south.

ORIGIN OF THE MOOR FLORA.

If we may judge from the actual conditions existing now in Arctic regions, immediately succeeding the glacial epoch this whole region was clothed with a vegetation resembling that now existing in our moors, indeed, resembling it much more than does any other feature of our present flora with the possible exception of the Alpine plants still persisting on our mountain tops. It is indeed an extraordinary circumstance that our lowest (in altitude) regions and our highest regions should have preserved to us a flora which is, for the most part, extinct. Since the Alpine plants and many of the bog plants draw nearer and nearer together so far as situation goes, as we go northward, until finally we find them mingled, our statement of the case is a correct one, and confirms the idea that our moor floras are remnants of an Arctic vegetation once predominating here.

THE RAPID ACCUMULATION OF MATERIAL IN THE DEPRESSIONS.

Although such a condition may not have actually existed, we may assume, for the purpose of illustration, that one of the depressions caused by the ice in this movement was left naked by the sudden lowering of the water level in the region. A lake would be left in the depression. The moisture held in the soil of the surrounding hills would steadily gravitate toward the lake and form springs. The water from these would often more than offset the loss of water from the surface of the

lake by evaporation. On the shores of these lakes would be afforded a congenial place for the first plants, among which, no doubt, sphagnum was prominent. The available food supplies in the soil of the hills around was washed and afforded food for these plants. As plants grew upon the hills, vegetable humus accumulated, and the wash from this further enriched the soil at the shore. But while this washing contributed something to the accumulations of the swamp, it, under no circumstances, can be compared to the soil washed down upon the flood plains of upland streams, and for the reason that these streams are not rapid enough to carry much solid material. The accumulations in the swamps are almost entirely the decayed plants that have grown there.

ABILITY OF THE LAKE TO RESIST INVASION.

The factors which determine the ability of the lake to resist invasion are its depth and the character of its shores. If the conditions are right, a lake even of considerable depth will be steadily encroached upon by vegetation. On the other hand a shallow lake will grow over much more rapidly. There is a popular notion that a cranberry bog may grow right over a lake, and that the flexible turf is like a blanket spread over the surface of the water. Walking on these places certainly gives one that impression. I have never seen a case where this was the actual condition of affairs. If you penetrate the turf anywhere you will find the blackest and softest kind of mud, almost as mobile as water, but as a plant food much more nutritious. From a boat there sometimes appear deep recesses far under the turf, but these are more apparent than real. There are often recesses under the turf, just as there are under harder shores, but these are not deep, and I feel reasonably sure that the floating moors float upon mud rather than upon water.

THE EFFECT OF WIND UPON THE RELATIVE POSITION OF LAKE AND BOG.

The position of the lake, with reference to other parts of the swamp has attracted my attention for some time. The lakes in the northern and western parts of Oswego County have, as

a general rule, their eastern shore hard, while the others are bordered by moors or by wooded swamps which are but matured portions of a moor. This is true of Mud Lake, Lake Neatahwantah, Paddy Lake, and the small lake in the Lily Marsh, all within twelve miles of Lake Ontario. At one time I thought the scarceness of springs might account for the failure of moors to form. But further observation led me to think their meagre occurrence on this shore the result, rather than the cause, of the absence.

There is what seems to me sufficient evidence to show that it is the action of the waves upon the eastern shore that prevents the formation of bogs there. At Mud Lake I have seen large masses of sphagnum and other plants from the west side of the lake lodged upon the east shore. Instead of taking root and growing they were soon washed to death by the waves. The action of the waves is very vigorous on the east shore of all the larger lakes. It is true also that where lakes are well-nigh filled up and the force of the waves is comparatively slight, the moor will begin to build from the eastern shore, but the belt constructed will be narrow compared with that on the other shores. This is the condition now existing in the Lily Marsh. Still another consideration points in the same direction. The small lakes in this particular region and the larger ones more remote from Lake Ontario have bogs on all sides of them.

Anyone who has lived in the region need not be told that prevailing winds are from the west. Their intensity, which, by the way, is often considerable, depends upon the long stretch of open lake to the west, and also, perhaps, somewhat upon the saturated condition of the atmosphere as it is swept in from the lake. The wind from Lake Ontario is so strong as to produce a decided effect upon the trees growing near the shore. They stretch their branches and often, indeed, lean toward the southeast. Another striking illustration of the power of the winds on the lake shore is seen in the great drifts of sand along the shore, sometimes called sand-dunes. Nor is the drifting of sand confined to the immediate shore of the lake. There is a sand hill in the town of Albion near a ham-

let called Dugway, quite as far from the lake shore as the lakes we are discussing, where the wind drifts the sand very considerably. Another one is said to occur between Sand Bank and Centerville in the same town. A visit to the former showed that the wind was actually moving a hill east, moving it grain by grain, but nevertheless very rapidly. The highway running north from Dugway formerly passed along the east side of the hill near its base. Old residents told me that the hill was originally wooded. After being cleared away it was cultivated and finally was seeded and used as a pasture. The work of the wind began when it was used as a sheep pasture. The sand drifted into the road until the people were hardly able to haul loads over it. An attempt was made to stop the sand by building a high board fence. The sand immediately began to drift against the fence and finally drifted over it, so that now only the tops of the boards can be seen. Failing in their attempt to fence out the sand, the people have bridged it over with planks for a distance of forty rods or more. All this goes to show that the west winds in this region are unusually strong, and produce a decided effect upon other features of the region as well as upon the lakes.[1]

UNIFORMITY IN MOOR FLORA.

One of the strongest pieces of evidence to support the view that the whole face of the country was once covered with a vegetation much more like that in our moors than like that upon our highlands, is the uniformity of the moor flora. The sphagnous moors are isolated, but we find the same species of plants in them all. It is impracticable for plants to migrate from one to another at the present time. The moors remind one of an island in the open sea—islands which preserve to us a primitive flora.

So constantly are certain species present in the moors of the whole eastern United States, that upon entering a moor one begins to look for certain species, and at once misses any one that does not happen to occur in that particular moor. An

[1] Since writing the above, Warming's *Oekologische Pflanzengeographie* has appeared, and in it, p. 365, is described the effect of the wind upon the lakes and moors of Denmark. The effect is the same as here described.

example: *Kalmia glauca* does not now occur in the Cayuga Lake basin, but it occurs in many of the moors to the east and north, even appearing in the adjoining county, i. e., Cortland.

THE ZONES OF A SWAMP.

The character of the vegetation enables us to divide a complete swamp into three natural zones:

First, the *lake* in the center, which, although not a belt at all, may, for convenience sake, be so designated.

Second, the *moor* comprising the open area surrounding the lake and generally grown over with sphagnum. There are no shrubs or trees here capable of casting extensive shade.

Third, the *wooded belt* comprising the remainder of the swamp. It varies in width, and in this particular region is apt to be of considerable width north and south of the lake.

In the maturing of the swamp these disappear in regular succession from one to three. Local conditions bring about a great variation in the relative extent of the several zones. At Malloryville, Tompkins County, N. Y., is a swamp with a very narrow wooded belt, due, no doubt, to the steepness of the shores of the depression; the lake here has been completely filled up, so that we really have a moor surrounded by high ground. The wooded belt is, however, a marked feature of the swamps in Oswego County.

(*To be continued.*)

EDITOR'S TABLE.

THE next issue of the AMERICAN NATURALIST will appear under entirely new management. The magazine has been purchased from the estate of the late Professor Edward D. Cope by a number of gentlemen who are interested in the advancement of the natural sciences, and Dr. Robert P. Bigelow, of the Massachusetts Institute of Technology, Boston, has accepted the post of Editor-in-Chief. He will be assited by an Editoral Committee and by an able board of Associate Editors,

whose names will be announced later. The general scope of the journal will remain unchanged, and a high standard will be maintained in every department. It is hoped that naturalists in all parts of the country will find the AMERICAN NATURALIST a convenient medium for such of their communications as may be of general interest to others working in the same general field, as well as to specialists in their own lines. Intending contributors are invited to send manuscripts directly to Dr. R. P. Bigelow, Massachusetts Institute of Technology, Boston, Mass.

THE meeting of the Association of Agricultural Colleges and Experiment Stations at Minneapolis, in the month just past, cannot fail to be productive of good. It brings out forcibly the endeavors of Americans as a people to ameliorate the conditions of the agricultural classes, reminding us, as it does, that some $1,890,000 were appropriated by Congress for the fiscal year ending June 30, 1898, for agriculture. Of this something like $1,170,000 is for scientific investigations under the direct supervision of the Department of Agriculture, and the rest ($720,000) for maintaining the experiment stations. The departmental divisions falling within the domains covered by the American Naturalist receive various amounts as follows: Botany, $23,800; Agrostology, $18,100; Forestry, $28,520; Pomology, $14,500; Physiology and Vegetable Pathology, $26,500; Biological Survey, $27,560; Entomology, $29,500; the Bureau of Animal Industry, $755,640; and for special investigations in nutrition under the auspices of the office of Experiment Stations, $15,000.

At this meeting, among the important matters brought to light was the relation between experimental and instructional work as it exists in some of the institutions represented in the Association. The complaint was made that experimental work suffers at the expense of instructional through the overloading of the workers. Many a teacher who should have some time to carry on original work is so crowded with class work that neither energy nor time is left for anything else. The result is that those whom he is supposed to teach are forced back, more or less, into the old parrot methods of learning, lacking as they do that best of incentive to a development of their own powers, namely, the living example of an original worker constantly turning out good work.

Another matter of importance that was touched upon is the indexing of literature relating to agriculture. So far as matter emanating from the experiment stations is concerned, nothing better could be asked for than the *Experiment Station Record.* But there is needed an index

that shall not be restricted to the immediately applicable—one that shall index thoroughly the entire range of the sciences, any portion of which appears at present capable of immediate use in agricultural lines. The development of the agricultural colleges should be broad and healthful and not the reverse.

Finally, there was a proposition, which was referred to the Executive Committee, to endeavor to obtain from Congress for the development of mechanical schools and courses of instruction the same encouragement that has been accorded to agriculture. The proposition is eminently a worthy one, for no class of the people, if one may judge from census returns, needs such encouragement more than this.

RECENT LITERATURE.

The Coccidæ of Ceylon.[6]—The work by Mr. E. E. Green, now to be reviewed, might seem from the title to possess very little general interest. Ceylon is a long way away; and the Coccidæ are apparently considered by most people to be unworthy of serious attention, except with a view to their destruction. Now while the economic side of Coccidology is highly important, it is maintained that the subject possesses also a strong Darwinian interest, and that the perusal of such a work as Mr. Green's will—or should—grealy profit any naturalist who interests himself in general biological problems. We have in these Coccidæ a strictly Homopterous type, but so modified that the family falls outside most of the current definitions—not only of Homoptera, but of Insecta! Combined with a remarkable reduction and even loss of parts, is the development of new characters of the most diverse kind to meet the several needs of the insects. We have here a case in which the most extraordinary modification has taken place, without masking the real affinities of the group; and everything is made so clear by Mr. Green's descriptions and beautiful colored plates, that no intelligent person could fail to understand the exact condition of affairs.

Not only should the work be examined by naturalists, but it should be shown to students of biology in our colleges. It ought to encourge all those who aspire to do original work in biological science. For

[6] The Coccidæ of Ceylon, by E. Ernest Green, F. E. S, Part 1. With 33 Plates. London, Dulaw & Co., 1896.

very many years, naturalists have collected and observed in Ceylon; yet here comes Mr. Green, at the end of the nineteenth century, and reveals a whole series of remarkable forms whose existence had remained unknown. Until Mr. Green began to study Coccidæ, the species of this family had never been collected or studied properly in any part of the great Oriental region, and for Ceylon only seven species had been recorded. Mr. Green has found considerably over a hundred, most of them new to science, and he estimates that over two hundred will eventually be found in the island. Of the 30 forms described in the part of the work now before us, 18 were first described by Mr. Green. And there are innumerable other localities in the world, where the Coccidologist may reap a similarly abundant harvest. There is a tradition among Entomologists, that these insects are extraordinarily difficult to study. The difficulty is much more imaginary than real; the methods of preparation for study are different from those required for other insects, but they are easily learned, and the characters of the species are readily determined with the aid of a hand lens and a compound microscope. The method of procedure is fully explained by Mr. Green in his prefatory remarks. There is one thing, however, to be remembered: No one can intelligently study the Coccidæ of one country or region alone; since through human means the distribution of many of these creatures has become almost or quite world-wide, and one never knows what may turn up at any place. In the first part of Mr. Green's work, there are recognized in Ceylon various species first described from such diverse regions as Europe, America, Australia and Japan.

In Chap. III, Mr. Green gives a new classification of the subfamilies of Coccidæ. He remarks himself, that it is doubtless imperfect; but it appears to the writer to be an improvement on all previous ones. It is especially to be recommended for its clearness and consistency, and while it must be admitted that on several points there still exists room for legitimate differences of opinion, the expected changes must chiefly depend on hitherto undiscovered facts. Mr. Green's new subfamilies, *Conchaspinæ* for *Conchaspis*, and *Tachardiinæ* for *Tachardia*, seem entirely justified. The writer regrets the suppression of the *Asterolecaniinæ*, which certainly form a very compact and natural group; while as to *Porphyrophorinæ*—he has never studied *Porphyrophora*, but *Margarodes* surely belongs to a subfamily distinct from *Monophlelinæ*. It is to be supposed that the *Orthezinæ*, *Monophlelinæ* and *Margarodinæ* (or *Porphyrophinæ*) are the most primitive of the Coccidæ. The writer inclines to the view that the *Conchaspinæ* are related to the ancestors of the *Diaspinæ*.

Chap. IV, relates to the *Conchaspinæ.* On June 9, 1892, being the first anniversary of our wedding day, my wife and I, then living in Jamaica, celebrated the occasion by a trip to Hope Gardens. It was on this occasion that *Conchaspis* was discovered. The next year, Mr. Newstead reported the same genus (as *Pseudinglisia*) and apparently the same species, in an English hot-house. Now Mr. Green describes a very distinct new species (*C. socialis*) from Ceylon, and for the first time makes known the ♂; and I may add that Prof. Townsend has found in Mexico, on *Phemicria* at Vera Cruz, still another species, which I shall publish as *C. newsteadi.*

Chap. V treats of the *Diaspinæ*, with a very admirable introduction. The genera found in Ceylon are *Aspidiotus, Aonidia, Mytilaspis, Diaspis, Fiorinia* and *Chionaspis.* The absence of *Parlatoria* and *Ischnaspis* is noteworthy. In the writer's opinion, two or three new genera should be added to those listed by Mr. Green. The extraordinary *Aonidia corniger* Green, is unquestionably the type of a new genus, which may be called *Greeniella*, distinguished by the long radiating processes of the scale, and the simple pygidium of the ♀, armed, however, with long irregular terminal processes. *Aonidia bullata* Green, and *Fiorinia secreta* Green, also obviously require new generic names.

Aspidiotus ficus is credited to "(Riley) Comstock," it should properly be credited to Ashmead, who first described it. Riley expressly disclaimed responsibility at the time. For *A. trasparens* or *lataniæ* are described and figured two different varieties of ♂, one reddish, the other pale yellow with a reddish thoracic band. The latter is the typical *transparens.* The species described as *A. cyanophylli* is apparently not Signoret's insect of that name; at all events, specimens sent to me by Mr. Green are distinct. These are on *Cycas* from Kandy, and will be published elsewhere as *A. greenii.* In *Aspidiotus secretus*, Mr. Green describes for the first time the adult ♀. Under *Diaspis amygdali*, it is noted, among other things, that the females (not the scale) on *Callicarpa lanata* are bright pink. *Diaspis fagrææ* Green, is a very interesting species, for while the ♀ is like an *Aulacaspis*, the ♂ scale has no trace of carination.

One of the interesting facts developed is that of the gall-producing propensities (if one may so speak) of *Grevia orientalis.* On this plant are found three galls, outwardly almost identical, one due to *Aspidiotus occultus*, one to *Fiorinia secreta*, and the third to a fungus! And what makes the case so extraordinary is, that these are the only true gall-producing *Diaspinæ* known!

I believe that what Mr. Green now calls *Mytilaspis gloverii* var. *pallida* is a distinct species, as he at first held. Mr. Alex. Craw has found on variegated *Podocarpus* from Japan a form which I propose to call *M. pallida* var. *maskelli,* because it was discussed by Mr. Maskell in Trans., New Zealand, Inst., XXVII, p. 46. The scale is too broad for *gloverii,* but narrower than *citricola;* it is not far from the color of *citricola,* not very pale as in typical *pallida,* though often whitish at the broader end. There seem to be but four groups of ventral glands, caudolateral four, cephalolaterals six.—T. D. A. Cockerell.

Section Cutting and Staining.[7]—This is intended primarily for students and practitioners who need a brief introduction to the ways of the microscopist. It briefly describes the necessary apparatus, and the various processes to which tissues are subjected for histological purposes. In many respects it may be said to be fairly up to date, in others, as for instance, in the case of bichromate of silver methods in neurology, it is not. Formol is given as a histological reagent, but unfortunately it is given as *formal,* which is a synonym for *methylal,* as has been previously pointed out in these pages, and as any one may readily see by consulting German works on organic chemistry or by consulting Gould's "Students' Medical Dictionary"[8] (1896, Phila.). By reason of priority, and by reason of its expressing the probable relations of the formaldehyde to the water in the so-called 40 per cent. solution, formol is the proper word to use for this liquid. But as the term Formalin has been forced into use in the commercial world and will probably stay in spite of efforts to supplant it, one may as well submit and use the word that one must employ in buying one's reagents. It is obvious, that, if one calls for formal, one will get methylal.

Cambridge Natural History, Volume V.[9]—The high standard of this series as a reliable, popular scientific work is maintained in this volume. Mr. Sedgwick contributes a paper on Peripatus, giving its habits, manner of breeding, anatomy, development, and a summary of distribution, the latter point being illustrated by a map. Mr. Sinclair treats of Myriapods in the same comprehensive manner, and includes a brief account of fossil forms and their distribution. Mr. Sharp gives an introductory sketch of Insects embodying the latest observa-

[7] Section Cutting and Staining. W. S. Colman. 12 mo. 160 pp.

[8] Or any one of several other Medical Dictionaries.

[9] Cambridge Natural History Series, Vol. V. Peripatus, A. Sedgwick. Myriapods, F. G. Sinclair. Insects, D. Sharp. London and New York, 1895. Macmillan & Co. $4.00.

tions as to their structure, the development of the individual, and the characteristic features of insect life, followed by a discussion of four of the nine orders of Insects, viz.; Aptera, Orthoptera, Neuroptera and a portion of the Hymenoptera. In these ordinary descriptions Mr. Sharp has incorporated a great deal of interesting information as to the habits and life-histories of various insects, fully demonstrating that fact may be as entertaining as fiction.

Aquatic Insects.[10]—This little volume is intended by the author to stimulate young naturalists in observing the habits and structures of living animals, and to try to discover the way in which the machinery of nature works. The writings of the old naturalists, Swammerdam, Réaumur, Lyonnet and De Geer are quoted to show what patient observation can accomplish. Eleven chapters are devoted to as many groups of fresh-water aquatic insects, one to the insects of the sea-shore and one to the peculiar contrivances of aquatic insects for locomotion, for feeding, for respiration, for egg-laying, and for attack and defence.

The drawings are in most cases made direct from the Insects and are a valuable feature of the book.

Bird-Craft.[11]—In gathering material for this delightful adddition to ornithological literature, its author has certainly had about her that "pocket full of patience" which she recommends to amateur students of bird-life. The chapters on the Spring Song, Building of the Nest, and Birds of Autumn and Winter show a long continued personal acquaintance with the habits of birds. The "Biographies" also contain notes from personal observation.

The illustrations, nearly all colored, add much to the attractiveness of the book.

Some Elementary Botany.[12]—Four very pretty books for Children have been compiled by M. C. Cooke and published by T. Nelson & Sons. The writer adopts the conversational style and imparts considerable information to his class concerning a few of the commoner English wild-flowers. A corn-field, a copse, a lane and a marsh afford material for the several books. Each volume is illustrated with a number of figures and one colored plate, and they are altogether attractive additions to literature for children.

[10] The Natural History of Aquatic Insects. By L. C. Miall. London and New York, 1895. Macmillan & Co. $1.75.

[11] Bird-Craft. By Mable Osgood Wright. New York, 1895. Macmillan & Co. $3.00.

[12] Around a Corn-field. A Stroll in a Marsh. Through the Copse. Down the Lane and Back. By Uncle Matt (M. C. Cooke), London, Edinburgh and New York, 1895. T. Nelson & Sons, Pub.

The Senile Heart.[13]—In this small octavo of some three hundred pages, Dr. G. M. Balfour states the causes for the enlarged heart frequently found in adults past their prime, its symptoms, and the concomitants and sequelæ. He then suggests a general mode of treatment for this widespread cardiac trouble followed by a chapter on the prognosis of special symptoms and the treatment with special reference to these symptoms.

Marginal synopses of the points touched upon in the several paragraphs make the book a handy reference volume.

Sixth Annual Report of the Missouri Botanical Gardens.[14]—This Report includes the following scientific papers: Revision of the North American species of Sagittaria and Lophotocarpus, Jared G. Smith; *Leitneria floridana,* Wm. Trelease; Studies on the Dissemination and Leaf Reflexion of *Yucca aloifolia* and other Species, H. J. Webber; Notes on new or little known Species, J. G. Smith; Notes on the Mound Flora of Atchison Co., Missouri, B. F. Bush.

All of these papers are well illustrated with page plates of excellent drawings.

AMERICAN NATURALIST LIST OF RECENT BOOKS AND PAMPHLETS.

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Adler, F.—The Monroe Doctrine and the War Spirit in the United States. Ethical Addresses, Ser. III, No. 1, 1896. From the author.

Agassiz, A.—The Elevated Reef of Florida, with Notes on the Geology of Southern Florida by Leon S. Griswold. Extr. Bull. Mus. Comp. Zool. Harvard Coll., XXVIII, 1896. From the author.

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Bascom, F.—The Structures, Origin and Nomenclature of the Volcanic Rocks of South Mountain. Reprint Journ. Geol., Vol. I, 1893. From the author.

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Bauer, K.—Ein Fall von Verdoppelung der oberen Hohlvene und ein Fall von Einmündung des Sinus coronarius in den linken Vorhof. Jena, 1896. From the author.

[13] The Senile Heart. Its Symptoms, Sequelæ, and their Treatment. By G. W. Balfour, M. D. New York and London, 1894. Macmillan & Co. $1.50.

[14] Sixth Annual Report of the Missouri Botanical Gardes. St. Louis, 1895.

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KINKELIN, DR. F.—Einige seltene Fossilien des Senckenbergischen Museum. Aus. Abhandl. Senck, naturf. Gessell., Bd. XX, Heft 1, 1896. From the author.

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General Notes.

GEOLOGY AND PALEONTOLOGY.

Hollick on Block Island.—The series of investigations carried on by Mr. Arthur Hollick in Staten Island, Long Island, Martha's Vineyard and Nantucket now includes Block Island. For several years Mr. Hollick has carefully recorded his observations, and has accumulated a vast amount of geological information, based on both paleontologic and stratigraphic data. His latest views on the relations these islands bear to each other are given in a recent paper as follows:

"Block Island has been brought into a line geologically with Long Island, Martha's Vineyard and Nantucket. They all had their origin in one series of cause and effect. They manifestly represent remnants of the former coastal plain which consisted of Cretaceous and Tertiary sands, gravels, clays and marls. The glacier of the Ice Age squeezed upward and pushed forward these incoherent strata into a series of contorted folds along its line of furthest advancement, depositing on top the detritus of the moraine. The ridge so formed was at first continuous, but with the gradual sinking of the coast, and the action of the ocean, the less elevated portions have succumbed, and only the highest parts, now represented by these islands, remain above water. All the facts point to this conclusion, and even the most superficial observation shows that the phenomena of submergence and erosion are in active operation at the present time. Should they continue in the future it requires but little prevision to appreciate that Block Island and the islands to the eastward will continue to shrink in size, disappear, and eventually form merely parts of the shoals which now connect and surround them. Montauk Point will continue to recede, and, by the submergence of the low, narrow strip of land in the vicinity of Canoe Place, a new island will be formed from what remains of the Point." (Trans. N. Y. Acad. Sci., XVI, 1896.)

Age of the Himalaya.—In a discussion of the geology of Hazara, India, Mr. C. S. Middlemiss again urges the great age of the Himalaya as opposed to the more popular idea that they were the product of yesterday, geologically speaking. He states that "it has been gradually becoming evident to all who really examine the question in detail that the Himalaya are and have been in a constant state of change; a state of elevation along the main axis and depression along the mountain-foot, with intermediate zones of crushing, crimpling, and over-riding

along shear and thrust planes. Hence, in speaking of the Himalaya of a past geological age or epoch I mean that old representative of them which held about the same position, and acted functionally in the same way as does the mountain range going by the name of Himalaya to-day. It may sometimes have been represented by long parallel coast lines, or by archipelagoes with chains of mountainous islands following similar parallel lines, but that it kept certain original features, and that a core recognizable in its unity persisted throughout Tertiary, Secondary, and possibly into Paleozoic times, I have no doubt." (Mem. Geol. Surv. India, XXVI, 1896.)

Geological History of the Bermudas.—Mr. Tarr's field work in the Bermudas results in the following conclusions in regard to the history of these islands as revealed by the rocks. First, there was a base rock, formed by the waves which ground up shell fragments upon the beach. This was consolidated into a dense limestone, which was elevated and denuded, and finally depressed and attacked by the waves. During the last stage it was partly covered by a beach deposit. Then came an uplift during which a wind-drift structure of consolidated coral sand was formed on the beach rock. The last stage has been a depression that carried the level down nearly to that of the beach which was formed before the uplift occurred. This work of construction has been done in recent times, the history dating back into Pleistocene time only, or possibly early Cenozoic. (Amer. Geol., Vol. XIX, 1897.)

Canadian Paleozoic Fossils.—A systematic list of all the species from the Galena-Trenton and Black River formations of the vicinity of Lake Winnipeg, now in the Museum of the Canadian Survey, prepared by Dr. Whiteaves, is published by the Survey, with descriptions and illustrations of 26 new species. According to the author, the most striking feature of the fossils of the Winnipeg and Red River formations is the large size to which many of the specimens attain. Reference is made to one of the Receptaculitidæ (*R. owenii*) which is known to be 12–20 inches in diameter. Orthoceratites have been found measuring 4½ to 6 feet in length. Rough casts of the interior of spirally coiled discoidal shells, apparently allied to Barrandeoceras are nearly or quite two feet across. A siphuncle of *Endoceras crassisiphonatum*, which is also imperfect at both ends, is nearly 3 feet long, and the fin cheek of a trilobate, *Asaphus* (*Isotelus*) *gigas*, indicates a specimen that must have been twenty inches in length when alive.

A brief resumé of the exploration of the Lake Winnipeg limestones prefaces the descriptions of the fossils. (Paleozoic Fossils, Vol. III, Pt, III Ottawa, 1897.)

Kellaways Fauna in Baluchistan.—A monograph prepared by Dr. Noetling, and the Geological Survey of India, deals with the fauna of Kellaways from Mazár Drik, Baluchistan. The specimens which have unfortunately suffered more or less from deformation by pressure, have been carefully compared with the type specimens from the Jurassic beds of Kutch, which were worked out by Professor Waagen, and the following determinations have been made:

There are in all 22 species, of which 17 are determined specifically, while of 5 only the genus could be determined. Of the 17 forms identified 16 have already been described, while one form, *Perisphinctes baluchistanensis* is recognized as new.

The 22 species represent the following classes: Brachiopoda 2, Pelecypoda 3, Gastropoda 1, Cephalopoda 16. The character and distribution of these fossils indicates that the *Polyphemus* limestone in which they were found is the representative of the *Macrocephalus* beds of Kutch, and is homotoxial with the lower Kellaways beds of Europe.

Six page plates of lithographed drawings illustrate the work.

Fauna of the Wombeyan Caves, N. S. W.—At a recent meeting of the Natural History of Glasgow, Dr. Brown exhibited the following series of fossils from the bone breccia deposit which he had discovered recently in the neighborhood of the Wombeyan Caves in New South Wales:

1. Two almost perfect jaws of *Burramys parvus* Broom, a Diprotodont marsupial, chiefly characterized by its large grooved premolars. It is regarded by Dr. Broom as being intermediate between the Phalangers and the Macropodids. There is reason to believe that Burramys is the nearest known relative to the extinct pouched lion *Thylocoleo carnifex* Owen.

2. Two lower jaws and a specimen exhibiting the almost complete maxillary teeth of *Paleopelaurus elegans* Broom, a small Diprotodont believed to be intermediate between Petaurus and Gymnobelidens, and probably the ancestor of both.

3. Premolars and molars of *Pseudochirus antiquus* Broom, an extinct Ring-tailed Phalanger.

4. Lower jaw of *Dromecia nana* (Desm.), the small Tasmanian Dormouse-Phalanger.

5. Lower and upper jaws of *Phascologale flavipes* Waterh, the existing yellow-footed pouched mouse.

6. Lower jaw of *Phasacologale penicillata* (Shaw), the existing Brush-tailed Pouched Mouse. (Proceeds. Nat. Hist. Soc., Glasgow, Vol. IV, Pt. III (1895–96), (1897.)

A Region of Environmental Change.—One of the most important geological changes which has taken place along the Atlantic coast in recent times was the closing up of the Currituck Inlet, North Carolina, by drifting sands in 1828. Previous to that year this inlet formed such a passage from the ocean through a narrow outer beach into the waters of Currituck Sound as is formed by either the new or Ocracock Inlet to Pamlico Sound now. With the closing of the Currituck Inlet there was the conversion of upwards of one hundred square miles of shallow salt and brackish water to fresh water; and it is within the memory of men now living that the resultant changes were immediate and striking.

Previously the sound had been a valuable oyster bed. Within a few years the oysters had all died out and their shells may now be seen in long rows where they have been thrown out in dredging for a boat way in the Coinjock Bay, a southwestern extension of the Sound. Further there were such changes in vegetation as brought countless thousands of ducks of species that had been only occasional before. The salt water fishes were driven out and fresh water fishes took their place. (Amer. Journ. Sci., IV, 1897, p. 76).

Geological News.—GENERAL.—Mr. J. C. Branner questions the somewhat prevalent idea that rock decay is, like organic decay, a process of bacterial growth. He cites a number of authorities who are all agreed as to certain conditions favorable for the growth of bacteria, and quotes experiments to show that these conditions do not exist below certain limited depths of the soil. Since granites are often decomposed to depths of more than 100 feet, it is not probable that bacteria are responsible for this deep decay, or for any considerable part of it. (Amer. Journ. Sci., Vol. III, 1897.)

CENOZOIC.—The jaws of a true monkey have been found by Mr. Forsyth Major in the Æpyornis beds of Madagascar. From their size M. Gaudy infers that the animal was about as large as a man. The molar teeth recall Mesopithecus and Semnopithecus. In general appearance the teeth resemble those of the Old World monkeys, but their number corresponds with those of the New World. For this new fossil Mr. Forsyth Major proposes the name *Nesopithecus robertii.* (Revue Scient. (4) VI, 1896.)

Dr. J. C. Merriam notes the occurrence of marine Tertiary horizons at two localities in Vancouver Island—Carmanah Point and at the Sooke District. Thirty-three invertebrate species are identified from

the first named place, and serve to correlate the formation with Conrad's Astoria Miocene. The fauna of the Sooke beds is quite different from any of the Oregon or Californian Miocene or Pliocene faunas known to the writer. His conclusion, however, from evidence in hand, is that the Sooke beds are of middle Neocene age, and that the time of their deposition was considerably later than that of the Carmanah Point beds. (Univ. Calif. Bull., Dept. Geol., Vol. 2, 1896.)

A recent Bulletin of the *Soc. Belge de Geol.* contains a figure of the femur of the anthropomorphous monkey found by Kaup in the Pliocene beds (Rhenan) at Eppelsheim (Haut-Rhin). At first it was decided not to separate this form generically from the Dryopithecus of Saint-Gauden's, but a recent critical comparison made by Pholig demonstrates that such a distinction should be made. He therefore proposes the name *Paidopithex rhenanus* for the Eppelsheim species. A comparison of the Rhenan femur with those of modern allied forms shows it to be more anthropomorphous, both in general and in many details, than are those of the Gorilla or the Chimpanzee. (Bull. Soc. Belge de Geol., 7, IX (1895), 1897.)

BOTANY.[1]

The Death of Sachs.—The death of Dr. Julius von Sachs, in Würzburg, on May 28th, is announced. He was born in Breslau in 1832, and was therefore sixty-five years of age at the time of his death. He was educated in the University of Prague, and in 1859 became assistant in physiological botany in the Royal Experiment Station at Tharandt, Saxony. In 1861 he became professor of botany in Bonn; in 1867 in Freiburg, and in 1868 in Würzburg. His most noted works are *Handbuch der Experimental-Physiologie der Pflanzen* (1865); *Lehrbuch der Botanik* (1st edition, 1868; 2d, 1870; 3d, 1873; 4th, 1874). *Geschichte der Botanik* (1875), *Vorlesungen über Pflanzen-Physiologie* (1882), and *Abhundlungen über Pflanzen-Physiologie* (1892). Of these the third and fourth editions of the *Lehrbuch*, *Geschichte* and *Vorlesungen über Pflanzen-Physiologie* were translated into English, and have been for years familiar to all classes of botanists in this country. The appearance of Bennett and Dyer's translation to the third edition of the *Lehrbuch* in 1875 marked an epoch in botany in America. The

[1] Edited by Prof. C. E. Bessey, University of Nebraska, Lincoln, Nebraska.

German edition had been read just enough to prepare botanists for the English volume, which was received with the greatest favor. It at once became the great reference book in many a college department of botany, and this place it has maintained in many cases to the present time, although it is now nearly a quarter of a century since the author wrote the German edition. In 1882, Dr. Vines brought out an English version of the fourth edition, with additions and explanations of his own, thus bringing the work forward practically to the date of its issue. This, like its predecessor, has been extensively used as a work of reference. In 1887, Marshall Ward brought out the "Lectures on the Physiology of Plants," and in 1890, Garnsey and Balfour the "History of Botany."

The unusual clearness with which he was able to express his ideas contributed greatly to the popularity of Sachs's writings, and this, added to his power of discriminating between the less and the more important factors in the problems which presented themselves, made him one of the most helpful of modern botanists.—CHARLES E. BESSEY.

Opportunities for Research in the Missouri Botanical Garden.—A recent circular by the director calls attention to the Garden as affording opportunities for certain lines of research in botany. He says, "For this purpose additions are being made constantly to the number of species cultivated in the grounds and plant houses, and to the library and herbarium, and, as rapidly as it can be utilized, it is proposed to secure apparatus for work in vegetable physiology, etc., the policy being to secure a good general equipment in all lines of pure and applied botany, and to make this equipment as complete as posible for any special subject on which original work is undertaken by competent students.

"A very large number of species, both native and exotic, and of horticulturists' varieties, are cultivated in the Garden and Arboretum and the adjoining park, and the native flora easily accessible from St. Louis is large and varied. The herbarium, which includes over 250,000 specimens, is fairly representative of the vegetable life of Europe and the United States, and also contains a great many specimens from less accessible regions. It is especially rich in material illustrative of Cuscuta, Quercus, Coniferae, Vitis, Juncus, Agave, Yucca, Sagittaria, Epilobium, Rumex, Rhamnaceae, and other groups monographed by the late Dr. Engelmann or by attachés of the Garden. The library, containing about 12,000 volumes and 13,000 pamphlets, includes most of the standard periodicals and proceedings of learned bodies, a good

collection of morphological and physiological works, nearly 500 carefully selected botanical volumes published before the period of Linnæus, an unusually large number of monographs of groups of cryptogams and flowering plants, and the entire manuscript notes and sketches representing the painstaking work of Engelmann. A complete author's catalogue of the library, shelf-marked to indicate the principal subject contents of the several works, is now in process of preparation, and will shortly be published.

"These facilities are freely placed at the disposal of professors of botany and other persons competent to carry on research work of value in botany or horticulture, subject only to such simple restrictions as are necessary to protect the property of the Garden from injury or loss."

It has been the hope of the editor of this department of the NATURALIST that the Missouri Botanical Garden should become a great inland laboratory for research in systematic, morphological and physiological botany, to which duly accredited students might be sent from the universities of the Mississippi Valley. There are many problems for whose solution botanists need tropical and sub-tropical laboratories, but there are many more for which just such facilities as are being provided by Dr. Trelease are far more useful; while the much milder climate of St. Louis, to say nothing of the difference in travelling and living expenses, still more fully justify the effort to establish this research laboratory. The returns for a certain outlay will be much greater than in some distant laboratory, and it will be far more profitable for universities to endow tables here than in less accessible places.

—CHARLES E. BESSEY.

Botanical Notelets.—Mr. C. G. Lloyd has issued his Second Report on the Lloyd Mycological Museum (Cincinnati, Ohio), from which we learn that on the first day of January, 1897, it contained 1431 specimens, representing 760 species. From it we learn also that the botanical library of the Museum contains 4387 bound volumes and about 2000 pamphlets. In this connection we may mention again the series of beautiful photogravures of American Fungi issued by Mr. Lloyd, in which the species are represented with wonderful fidelity.

Dr. C. Hart Merriam has recently described (Proc. Biol. Socy., Washington, **10**:115) a new species of fir tree from the San Francisco and Kendrick Mts. of Arizona. It has hitherto been confused with *Abies lasiocarpa* (Hook.) Nutt., (*Abies subalpina* Engelm.) from which it differs in its corky bark, longer leaves, smaller cones and broader scales. He names it *A. arizonica.*

Mr. T. C. Palmer describes (Proc. Acad. Nat. Sci., Philadelphia, March, 1897), a method of demonstrating the absorption of carbon dioxide, and the generation of oxygen, by diatoms, by the use of inverted test-tubes filled with water tinged with hæmatoxylin. On the addition of carbon dioxide the rosy tint turns yellow, and, as the diatoms absorb the acid, the rosy tint reappears.

The third of the "Teachers' Leaflets on Nature Study," issued by Professor Bailey, is entitled "Four Apple Twigs." Like its predecessors, it is certain to be very helpful to both teachers and students.

Professor M. A. Brannon's paper on the "Structure and Development of *Grinnellia americana*," in the March number of the *Annals of Botany*, brings out a number of interesting facts about this beautiful American red seaweed. He found this species to be particularly well adapted to the study of the various phenomena of reproduction. The plant, when cut into small pieces, reproduces vegetatively by proliferation. Carpospores and tetraspores germinate readily under favorable conditions which are easily controlled. The antherozoids (which are non-motile) are formed by abstriction. The trichogynes are often branched, sometimes as many as five growing from a cystocary. The pericarp is only two or three layers thick.

Mr. F. V. Coville publishes some interesting notes on the plants used by the Klamath Indians of Oregon (Contrib. U. S. Natl. Herb., V, No. 2) as one of the results of a botanical survey of the plains of southeastern Oregon in 1896. The plants considered range from lichens (*Alectoria fremontii* and *Evernia vulpina*) to grasses, lilies, knotweeds, roseworts, umbelworts, and composites. These plants are used for food, dyes, clothing, bows, arrows, baskets, buckets, medicines, etc.

Bulletin 9 of the Minnesota Botanical Studies maintains the high standard of this unique state publication. It contains papers on the Lichens of Minneapolis (*Fink*), the North American Hyphomyceteæ (*Pound* and *Clements*), Mosses at High Altitudes (*Holzinger*), Dorsiventral Leaves (*Day*), the Genus Coscinodon in Minnesota (*Holzinger*), the Ferns and Flowering Plants of the Hawaiian Islands (*Heller*), Symbiosis (*Schneider*), the Distribution of Woody Plants at Lake of the Woods (*MacMillan*), the Alkaloids of Veratrum (*Frankforter*).

H. J. Webber's paper on the Water Hyacinth (*Piaropus crassipes* (Mart.) Britton) in Bulletin 18, of the Division of Botany of the U. S. Department of Agriculture, describes the rapid spread in Florida rivers of a very pretty plant hitherto used for ornamental purposes, until it has now become an intolerable nuisance. It often seriously impedes, and, in fact, sometimes actually stops the progress of steamboats. The problem of its eradication is a very difficult one.

The Asa Gray Bulletin for June appears in an enlarged and improved form. The editors say in regard to it: "For some time it has been felt that there is room in the United States for a botanical magazine of a more popular nature than any which now occupy the field," and they hope to make the little magazine fill this place. G. H. Hicks of Kensington, Md., the Editor-in-Chief, is to be aided by a number of well known botonists. It should be widely circulated in the public schools.

M. C. Fernald's "Second Supplement to the Catalogue of Maine Plants" appears in the *Proceedings of the Portland Society of Natural History* (Vol. II, Part 4). It contains 101 species and varieties, several of which are described as new to science. Among the interesting additions are *Prunus cuneata* Raf., *Lythrum alatum* Pursh, *Coreopsis tinctoria* Nutt., *Fraxinus viridis* Michx. f., *Solanum rostratum* Dunal, and *Sassafras officinalis* Nees.

A new book on fossil plants is now appearing in parts from the publishing house of Ferd. Dummlers, Berlin. It is the work of Dr. H. Potonié, and bears the title of *Lehrbuch der Pflanzenpaleontologie.* The first *lieferung* contains 112 pages, and includes chapters on "fossil plants in general," "doubtful fossil plants," and a "systematic discussion of fossil remains." It is freely illustrated.

Professor F. Lamson-Scribner, the agrostologist of the Department of Agriculture, in Washington, D. C., has made a valuable contribution to our knowledge of the grasses of the United States by bringing out an illustrated bulletin (No. 7) under the title of "American Grasses," consisting of excellent figures of three hundred and two species. Accompanying each is a brief description. It is to be hoped that larger editions of these useful publications may be made in the future, so that they may receive wider distribution.—Charles E. Bessey.

VEGETABLE PHYSIOLOGY.

Chemotropism of Fungi.—Manabu Miyoshi, a student of Pfeffer in Leipsic, has considerably extended our knowledge of the behavior of fungi toward particular substances, and has opened up a wide field for speculation and experiment relative to the causes of parasitism. He experimented at first with six common fungi, all usually designated as Saprophytes, viz.: *Mucor mucedo, M. stolonifer, Phycomyces nitens, Penicillium glaucum, Aspergillus niger* and *Sapro-*

legnia ferax. Subsequently he also experimented with *Botrytis bassiana, B. tenella, Uredo linearis* and with the pollen of *Digitalis purpurea* and of some other Dicotyledons, the results being much the same except that they are attracted by fewer substances. In brief, he finds the germ tubes of the species experimented on to be indifferent to some substances, to be repulsed by others, and to be strongly attracted by still others. In some cases the attraction is so strong that an indifferent fungus-like Penicillium is converted into an active parasite by simply injecting the living leaves on which the spores are sown with a dilute solution of the attractive substance, e. g., 2 per cent. cane sugar. The germ tubes bore through the epidermis or enter at the stomata and ramify through the interior of the leaf, boring through cells as well as passing between them, while they show no tendency to enter leaves injected simply with water. The suggestiveness of this sort of an experiment is certainly very great. The spores were separated from the chemotropic substance by films of mica or collodium perforated with fine needle punctures, or by means of the epidermis of various plants. Without entering into details, some of the main conclusions reached by Mr. Miyoshi may be summed up in the following diagrams which I have prepared from his tables. These experiments were made with layers of gelatin separated by thin films of collodium containing fine needle punctures. The interrupted horizontal lines represent collodium membranes separating layers of 5 per cent. gelatin, previously washed in HCl to remove the disturbing, nutrient lime salts. The dotted areas indicate the particular layer of gelatin containing the spores to be tested. The diagonally shaded areas indicate the layers of gelatin to which the chemotropic substance was added, in these cases 2 per cent. cane sugar. The vertical lines represent the walls of the glass dishes. The arrows indicate the direction of the movement of the germ tubes when there was marked chemotropism. Zero denotes that there was no movement of the germ tubes into the compartment, and * indicates that the germ tubes grew indifferently in all directions. In the first diagram the experiments were with *Phycomyces nitens* and *Mucor stolonifer,* in the second with *M. stolonifer.*

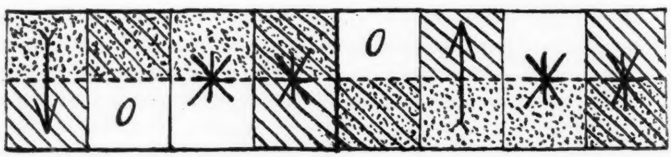

Fig. 1.

Mr. Miyoshi finds that within certain limits it is the difference in the concentration of the chemotropic substance in two layers rather than

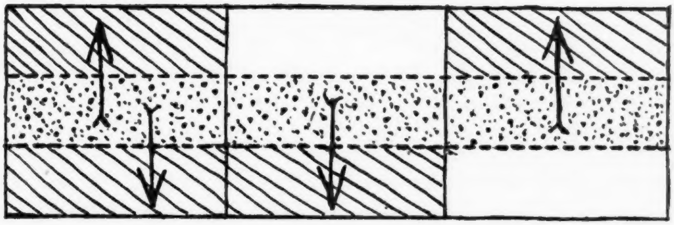

Fig. 2.

the amount of concentration which controls movement. Positive chemotropism gradually disappears as diffusion renders the concentration slight. The concentration difference must be 1 : 10 or more to induce decided turning. If the concentration is great, negative chemotropism is apt to set in, e. g., *Mucor mucedo* shows strong, positive chemotropism to 2 per cent. cane sugar solution, it is feebly positive with 0.1 per cent., while with diluter solutions the fungus does not react; with solutions stronger than 2 per cent. the positive reaction increases up to 10 per cent., and then slowly decreases at 15, 20 and 30 per cent., becoming negative at 50 per cent. We reproduce one of Mr. Miyoshi's figures showing the movement of the germ tubes of *Saprolegnia ferax* into a puncture in a collodium plate through which 2 per cent. meat extract was diffusing. Hyphae inside the circle of diffusion always turned their growing point toward the zone of higher concentration and finally entered the opening where it was strongest. Identical results were obtained in light and dark rooms. The experiments seem to have excluded heliotropism, geotropism and all movements due to simple contact.

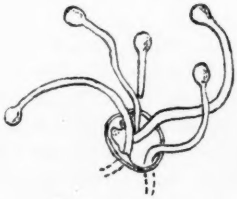

Fig. 3.

Pfeffer's capillary tubes in water or very dilute nutrient solutions under cover glasses were also used, but this method, while giving some interesting results, is stated to be better adapted to motile organisms. Many substances were found to attract, and a long list is given with the behavior of the six fungi first mentioned toward different concentrations. Among the strongly attractive substances were ammonia compounds, phosphates, meat extract, peptone, sugar, dextrin, asparagin, etc. The

following compounds caused repulsion: organic and inorganic acids, alkalies, alcohol, calcium nitrate, magnesium sulfate, sodium chloride, potassium nitrate, chlorate and chloride. The nutrient value of a substance, it is said, in no way corresponds to its chemotropic stimulus. Glycerin is cited as example of a good food which has scarcely any chemotropic action. The five molds were specially attracted by sugar, while the Botrytis showed a special preference for meat extract and peptone and no liking for grape or cane sugar. The pollen tubes were indifferent to meat extract, peptone and asparagin, but were attracted by grape sugar, cane sugar, dextrin and plum decoction. The title of this paper is *Ueber Chemotropismus der Pilze.* It occupies all of *Botanische Zeitung.* 52 Jahrg. 1 Abt. Heft I., and is well worth reading by all who are interested in the cultivation of fungi.

—Erwin F. Smith.

ZOOLOGY.

Origin of Life.—The following interesting speculation as to the origin of the organic forms of the earth is advanced by Mr. Charles Morris. There was a time in the earth's history, when chemical inaction prevailed, on account of high temperature and unfavorable physical conditions, but, on the formation of an ocean of highly heated waters, holding in solution a variety of elementary substances and simple compounds, chemism grew active, and became more energetic as the waters increased in depth and in variety and volume of their contents. Many complex minerals were very likely then formed and deposited as rock formations. As the ocean became freed from its abundance of foreign material inorganic chemistry decreased, until now it has practically ceased, oxidation having reduced nearly all substances to a state of chemical fixity.

As the waters of the primeval ocean slowly cooled, and inorganic chemism declined in activity, organic chemism probably set in, aided by the solar rays. The material for this new phase of action had been prepared and existed abundantly in the water and air. It may have had its origin in an early reaction between carbon dioxide and the elements of water, yielding the hydro-carbons; and subsequently between these and nitrogen, yielding the far more complex albuminous compounds.

Many of the preceding mineral molecules were quite complex in composition, and it is reasonable to suppose that still more complex molecules arose under conditions restraining the activity of oxygen. Seed forms of organic substance may have first appeared—simple carbon compounds. These would serve as the basis of more complex molecules, and there may have been a long-continued process of deoxidation and formation of higher carbon and nitrogen compounds until true organic matter appeared and the chemistry of life came fairly into play.

Further the author remarks that "the conditions favoring the development of organic material were transitory, and no longer exist. Organic chemistry emerged from a vitally active stage of inorganic chemistry. It could not well arise from the existing passive stage of inorganic chemistry." (Proceeds. Acad. Nat. Sci., Phila., 1897).

The Life Cycle of the Coccidii of Arthropods.[1]—During the course of his researches on the Sporozoa of Arthropods Liger came to the conclusion that the form that has been described under the name of Eimeria is not an independent animal but only a form in the life cycle of Coccidium. In the intestine of myriopods and of insects, embracing species of Himantarium, Stigmatogaster, Lithobius, Cryptops, and Tipula, two forms of the parasites were always present. In the myriopods there could be recognized, (1) cysts of Eimeria, growing and mature, enclosing numerous sporozoids regularly disposed and enveloped in a delicate wall; (2) free active sporozoids, that might be seen in the process of becoming detached from those just noted; (3) intra-cellular forms, among which one might recognize all the transitional forms between the sporozoids just noted and the encapsuled form marking the end of the period of growth; (4) encapsuled forms, free or still intra-cellular and showing the beginning of the division of their contents into four granular masses; (5) these same cysts in a mature condition with four oval spores each containing two sporozoids.

An examination of the excrement of a Himantarium that was later found infested showed the existence there of the cysts of Coccidium, which are to be considered as giving rise to Eimeria. The sporozoids of Eimeria were found incapable of existing in water. As further supporting his position he cites the fact that when Coccidium is present, so is Eimeria, and when one is absent, so is the other. This coëxistence of the two forms in the same animal has been long known, and it is added that an arthropod has never been found containing a Coccidium with lasting spores that did not also harbor an Eimerian form.

[1] L. Liger. C. R. Acd. Sci., CXXIV, pp. 966.

Summarizing his facts he states that the cycle of the Coccidium is as follows:

"Eimerian sporozoid, encapsuled form, tetra-spored cyst (Coccidium), Coccidian sporozoid (that enters the host), eimerian bud-group, and then the Eimerian sporozoid.

In a promised paper the author expects to show the relation between a coccidium and a gregarine, but not by an identification with a morocystial as Mingazine has attempted to do nor by a doubling of the cycle as Schneider did, but by considering the Eimerian sporozoid as equivalent to the gregarine sporo-blast and the lasting tetra-spored cyst of a Coccidium as the analogue of the gregarine spore.

The Nephridia of the Nemertine, Stichostemma eilhardi Montg.—A brief paper on this subject by Dr. Montgomery contains some very striking facts, which have a somewhat important bearing upon the weight to be given nephridia in constructing phylogenetic trees. As a case in variation the worm described simply adds another example to those that have been accumulated showing that the forms of animals, of plants, the number of various portions of their anatomy, etc. are much less fixed and regular than has been previously supposed.

This particular worm we are informed differs from all other known nemerteans (1) in having several consecutive nephridia on each side of the body instead of a single pair as is the case in others forms; (2) in the fact that not all of the nephridia are provided with excretory ducts; (3) in the nephridia extending from one end of the body to the other; (4) in the great number of excretory ducts; (5) in the cavity of the terminal bulbs being closed and hence not in open communication with the lumen of the ductules; (6) in the presence of a closed cuticular structure surrounding the cavity of the bulb which may be produced by the cells of the latter; (7) in the probable absence of a ciliary flame in the bulb; (8) in the comparative great length of the ductule connecting the bulb with the main duct; and (9) in the possession by the epithelium of the main ducts of a cuticula of considerable thickness.

No evidence of a connection between the nephridia and the blood vessels was found.

The peculiar features of the animal the author seeks to explain as due to the adaptation of the ancestors of the worm from a marine to a fresh water life. There is a question, however, as to whether such a cause is properly assumed for the peculiarity of consecutive nephridia instead of the single pair found in all other nemertines, and for the irregularities to be noted in the supply of excretory ducts. As shown by the

author's diagram the nephridia look fragmentary; there is no regularity in their length, nor do the numbers of the fragments show evidence of bilateral symmetry. But the author himself suggests that the specimen may be a monstrosity, and that a study of other specimens might show both bilateral symmetry and more regularity in the arrangement on each side. Such a further study is certainly needed. Until it is made one might very reasonably suppose that it is possible that the nemertine nephridia and their ducts are not stable in their arrangement. And this supposition would be supported by the fact that in Pauropus, —an animal much higher in the scale of life than the nemertine worm in question and therefore, according to general opinion, probably less likely to vary,—one finds the seminal ducts (metamorphosed nephridia) coiled upon themselves and anastomased in a most peculiar, manner with no evidence of bilateral symmetry and showing no evidence of constancy of arrangement or in the position of the three small ducts leading from the testes in different individuals. Further one frequently finds that portions of the large ducts have become cut off from the remainder and left without communication with the exterior, very much as is shown to be the case with the ductless nephridia in Dr. Montgomery's figure.

Description of a Remarkable Japanese Cirripede.—SCALPELLUM SEXCORNUTUM n. sp. General form of capitulum triangular, the ventral side nearly straight, dorsal convex; upper whorl of plates perfectly and normally calcified, lower whorl with small, peculiar plates. Valves 13. Surface everywhere densely and minutely pilose. *Carina* simply bow-shaped, weakly arched, the apex or umbo terminal above, roof strongly convex, with "eaves" or projecting carinæ at the sides, below which the side walls have some radial striæ. *Tergum* long, triangular, the carinal margin long. All margins rather straight, surface with some radial striation and a wide, but not well defined median rib, the apex erect, pointed. *Scutum* convex, subtriangular, decidedly less in area than the tergum, the occludent margin slightly concave, tergal margin straight, lateral and basal margins convex, surface radially striated. *Upper latus* somewhat triangular, the umbo above, at the apex; scutal margin long, concave, carino-basal margin convex. *Rostrum* triangular, as wide as long, the beak upturned and somewhat projecting. *Rostral latus, carinal latus* and *subcarina* developed as curved, projecting spikes or horns, small at their bases. No infra-median latus or subrostral plate. "Thorax"

Scalpellum sexcornutum Pils.

largely unprotected, collapsed in the dry specimens described. Peduncle rather short, not large, with small, sparse and separated conic scales.

Height of capitulum 18, breadth at base 11 mm.

The specimens described were collected by Mr. Frederick Stearns, and one of the cotypes is in his noble collection of Japanese invertebrates in Detroit, Mich., the other being in the museum of the Academy of Natural Sciences of Philadelphia.

The capitulum is covered with a soft dense pile, like *S. villosum* and *S. trispinosum;* but these are Pollicipeo-like species, very unlike *sexcornutum.* From all other species of similar contour, the peculiar development of the whole lower whorl of plates as projecting horns, will readily distinguish this species, which is apparentiy nearer *S. squamuliferum* Weltner (S.-B. Ges. Naturforsch. Fr. Berlin, 1894, p. 80) than any other described form. None of the forms described but not yet figured by Aurivillius (Ofversigt Kongl. Vet. Akad. Förh. 1892) seem at all similar.

It may be mentioned in this connection that the Japanese species described by me in 1890 as *Scalpellum Stearnsii* was redescribed in 1891 as *S. calcariferum* by my lamented friend Dr. Paul Fisher (Bull. Soc. Zool. de France, April, 1891, p. 117).

It is likely that these "horns," while certainly inefficient as an armour for the thoracic region, may be protective in function, as their acute, projecting points probably could not be comfortably masticated. —Henry A. Pilsbry.

The Orthoptera classified according to the characters of the Intestine.[2]—Continuing his studies upon the intestine and its appendages in the group of Orthoptera Bordas has made use of the facts in a classification of the group. The presence or absence of cœcal diverticula permits him to form two suborders, Colotasia and Acolotasia, and the number and arrangment of the Malpighian tubules allow him to decide each suborder into several families. Seven families in all are recognized. Until the first suborder, Acolotasia, distinguished by the absence of cæca the two families Phasmidæ and Forficulidæ are placed, which under the second suborder, Colotasia, the following five families are distinguished by the characters and in the order given:

(1) Blattidæ by a well developed gizzard, eight cæca, and by the Malpighian tubes being grouped in six fascicles.

(2) Mantidæ by a rudimentary gizzard and eight cæca, and by voluminous salivory glands.

[2] L. Bordas. Classification des Orthoptères d'après les caractères tirés de l'appareil digestif Compt. Rend., CXXIV, 821–3.

(3) Acridiidæ by six cæca each with a posterior diverticulum and by the absence of a gizzard.

(4) Locustidæ by a voluminous gizzard with six rows of chitinous teeth, by two large cæca, and by the numerous Malpighian tubes opening at the summit of small conical tubercles.

(5) Gryllidæ by a large gizzard thickly armed with chitinous teeth, by two cæca, and by the Malpighian tubules being grouped into large fascicles that empty at the enlarged extremity of an efferent canal playing the role of ureter.

A Preserve of Black Foxes.—A few years ago a tourist, convinced that the extermination of the Black Fox was but a question of a few years at the most, purchased an island, Outer Heron, at the mouth of the Maine, off the port of Boothbay, with the intention of establishing there a colony of the animals in which he was interested. He imported from Alaska thirty individuals, only seven of which survived the long voyage. These were liberated on the island, which is well wooded and watered, and were provided with a guard, whose duty it is to look after the increase of the original seven. They are fed on horse meat, which is left in the forest for them, but they themselves forage along the shore for fish and mollusks thrown up by the sea. They live for the most part about the coast, seeking shelter in the clefts of the rocks.

The owner finds his venture quite a profitable one, having arranged with a London firm to dispose of the skins of the surplus of his pack. (Revue Scientif., Avril, 1897.)

D. G. Elliott and his party obtained 125 species of birds during their expedition through Somali-land. A list of these species has been compiled by Mr. Elliott, who subjoins each species named with the field note pertaining to it. The author gives much valuable information concerning the habits of these African birds. A new Kestral is described, *Cherchuis fieldii*, and 7 other new forms representing the families Turdidæ, Sylviidæ, Alandidæ and Ploceidæ. The latter family, however, has only a subspecies representative. (Pub. 17, Field Col. Mus.. Ornith. ser., Vol. I, No. 2, 1897.)

A resumé of the species of known Costa Rican mammals is given by J. A. Allen. The total number of species enumerated is 121, of these 10 species are domesticated animals, and 4 are introduced species of Mus, leaving 107 as indigenous to Costa Rica. (Bull. Amer. Mus. Nat. Hist., Vol. IX, 1897.)

Metamorphoses of Leptocephalus brevirostris.—A description of the transformation of *Leptocephalus brevirostris* into *Anguilla vulgaris* has been published by G. B. Grassi and Dr. Caulandruccio. The reality of the metamorphoses described has been confirmed by the characteristics of another specimen of *L. brevirostris* captured last January by Dr. Silvestri in the Straits of Messina. (1) The head and point of the tail has noticeably acquired the special characteristics of the eel. (2) The larval teeth have totally disappeared, while the distinctive ones seem entirely absent. (3) It lacks all traces of pigment. (Atti della Reale Accad. Lincei, VI, 1897, p. 239.)

ENTOMOLOGY.[1]

An Ant-Inhabiting Mite.—M. Charles Janet continues his interesting records of Myrmecophilous insects (Comptes Rendus, 1897, p. 583–585). His latest study relates to the peculiar mite *Antennophorus uhlmanni* and its host *Lasius mixtus.* The mite lives on the ant as an epizoön. "It fixes itself on the lower surface of the head or on the sides of the abdomen of its host by means of the caruncul æ in which its feet terminate, and which are furnished with a very adhesive sticky substance.

These parasites are blind, but the first pair of feet is transformed into long antenniform appendages provided with very sensitive olfactory organs. They do not wander about in the galleries of the nest, but walks over the bodies of the ants, passing from one to another. When an *Antennophorus*, detached from the body of an ant, lies upon the soil in one of the galleries of the nest, it raises and stretches forward its first pair of ambulatory feet and at the same time it explores the space around it with its long antenniform feet. These appendages are much more agitated when an ant passes close by. If it pass near enough, the Acarid glues itself on to its body by means of the cup of sticky material on the end of one of its ambulatory feet, which it holds up ready for this operation, and it can in this way soon climb up and fix itself in a good position on its host. This latter is surprised, and seeks to rid itself of the new comer, but failing in this it becomes resigned very quickly as soon as the Acarid has taken up one of its normal positions.

[1] Edited by Clarence M. Weed, New Hampshire College, Durham, N. H.

Generally a working ant only carries a single *Antennophorus*, but they may very often be seen carrying several. In all cases the parasites take up positions symmetrical with the sagittal plane of their host's body, and it thus comes about that the center of gravity of the extra load is placed in the sagittal plane of the carrying ant.

The Acarids are also under the best conditions for not hampering the movements of the ants, and, as a consequence, for being the more readily tolerated by them. The *Antennophorus* directs its antenniform feet toward the front of the ant if fixed upon its head, and in the reverse direction if fixed upon its abdomen. When an ant carries but one *Antennophorus*, it is almost always placed on the head of the host. The case of an ant carrying an *Antennophorus* under its head and one on either side of the abdomen is very common. The presence of one or more of the parasites on the body of a Lasius does not prevent the latter from taking its share in the work of the colony and in particular the carriage of the larvæ and rubbish.

The *Antennophorus* attaches itself freely to the naked nymphs, but never to a nymph enveloped in a cocoon. Thus in an experimental nest consisting of some fifty ants, all carrying a single *Antennophorus* and accompanied by a certain number of nymphs, I found on the following day a newly emerged ant which bore seven *Antennophori* arranged symmetrically as follows: two (one on the top of the other) on either side of the head and on the abdomen, one on the middle of the dorsal region and one on either side. It would appear that the *Antennophorus* is attracted to the young ants on account of the care with which they are looked after and fed by their older companions. These latter do not seek to drive away the parasites which spread themselves a little later. At the moment when a queen throws off her nymphal envelope the workers come to her assistance, and as the workers carry the *Antennophori*, these latter generally take advantage of the position to pass over to the body of the newly emerged queen.

The *Antennophorus* feeds exclusively on the nutritive fluid disgorged by the ants. Fifty Lasii carrying *Antennophori* were placed in an observation nest and left without food. Eight days later the ants were in perfect condition, but ten or more *Antennophori* had already died of hunger. A tiny droplet of honey tinted with Prussian blue was allowed to run over the lower face of the glass plate which formed the roof of the nest. A large number of ants, nearly every one of which carried an *Antennophorus*, ranged themselves as closely as they could be packed all around the drop. The *Antennophori* had no share in the meal, and they were obliged to retire a little because there was no

room for them between the heads of their hosts and the glass to which they were applied. The ants of this brood had acquired the habit of placing themselves, crowded one against the other, in one corner of the nest, and there they came with their crops well filled after the meal of blue-honey, and there they disgorged before the mouths of their comrades who had none. Now the ant in the act of disgorging opens its mandibles wide. The peristaltic movements of the æsophagus and the movements of the pharynx brought up the globules of honey, the blue color of which made them readily visible, and they formed a little drop in front of the mouth. While the fasting ant was eating the honey thus disgorged, the *Antennophorus* riding on its head took its share. To do this it pushed itself forward and thrust its rostrum into the droplet. Generally, while holding itself in position by means of the two hinder pairs of legs, it attached itself by means of the forward pair to the head of the disgorging ant. Very often, when the fasting ant had ended its meal and was retiring, one would see the *Antennophorus* try to keep its hold on the disgorging ant. The two Lasii generally lend themselves to this prolongation of the meal, and if they are slightly separated from one another, the *Antennophorus* stretches itself to its full length, and forms, back downwards a sort of bridge between the heads of the two ants.—*Annals and Magazine of Natural History.*

The Spread of the Asparagus Beetle.—In the recent Yearbook of the U. S. Department of Agriculture, Mr. F. H. Chittenden describes the distribution of *Crioceris asparagi* in America. He writes:

From the scene of its first colonization in Queens County, New York, the insect migrated to the other truck-growing portions of Long Island, and may now be found at Cutchogue, toward the eastern end of the island. It soon reached southern Connecticut, and has now extended its range northward through that State and Massachusetts to the State line of New Hampshire. Southward, it has traveled through New Jersey, where it was first noticed in 1868, eastern Pennsylvania, Delaware and Maryland to southern Virginia.

Its distribution by natural means has been mainly by the flight of the adult beetles. Undoubtedly, also, the beetles have been transported from place to place by water, both up and down stream by rising and falling tide, as the fact that it has not until recently deviated far from the immediate neighborhood of the sea coast and of large water courses near the coast bears abundant testimony.

Another reason for the present prevalence of this species in these localities is that asparagus was originally a maritime plant and has

escaped from cultivation and grown most luxuriantly in the vicinity of large bodies of water. It is well known that it is usually upon wild plants that the insect first makes its appearance in new localities. There is evidence also that its dissemination may be effected by what Dr. Howard, who has made a special study of the distribution of this and other imported insect pests, has termed a "commercial jump," either by commerce in propagating roots, among which the insect may be present either as hibernating beetles or as pupæ, or by the accidental carriage of the beetles on railroad trains or boats.

Only by some such artificial means of distribution has it in later years found its way to northwestern New York, in four counties between Rome and Buffalo, and to Ohio, where it now occupies a similar territory of four counties between Cleveland and the Pennsylvania State line. During the past summer Dr. Howard traced its course along the Hudson River above Albany. Inquiry instituted by Mr. F. M. Webster concerning the Ohio occurrence disclosed the fact that the plants in one locality were brought from New York. Its presence in eastern Massachusetts in like manner may be due to direct shipments of roots from infested localities to Boston and vicinity.

It is noticeable that its inland spread, except in the neighborhood of water, has been extremely limited. It is present now in what is known as the Upper Austral life zone, although in certain points in New England it has located in what is considered the Transition zone. Its course up the Hudson River lies within a rather narrow strip of Upper Austral, and its location in the vicinity of Mechanicsville, about twenty miles north of Albany, marks its present most northern location. In all probability it is destined in time to overspread the entire Upper Austral zone and to make its way to some extent into neighboring areas in which it may find conditions for its continuance.

Notes.—In Bulletin 67, from the Kentucky Experiment Station, Prof. H. Garman discusses the San José Scale.

The Colorado Potato Beetle in Mississippi is the title of Bulletin 41 of the Experiment Station of that State. It was prepared by Mr. H. E. Weed, who shows that this pest is gradually approaching the Gulf Coast.

Mr. M. V. Slingerland treats of "The Army Worm in New York" in Bulletin 133 of the Cornell University Experiment Station.

W. M. Schöyen publishes (Entomol. Tedskrift, 1896, pp. 111–112) a short bibliography of Norsk Entomology for 1894–5.

Mr. Nathan Banks has described a number of new Neuroptera from North America (Trans. American Entomological Society, XXIV, 21).

EMBRYOLOGY.[1]

Some Activities of Living Eggs.—R. V. Erlanger[2] has published a brief account of the fertilization and the first cleavage stages of the eggs of several small Nematodes found in decaying earthworms; chiefly *Rhabdites dolichura* and *R. pellio.*

Some of the phenomena seen in the living eggs seem of special interest as adding to our knowledge of the amœboid power of egg protoplasm and at the same time furnish a welcome supplement to the results obtained upon the same and other nematode eggs by aid of reagents.

The sperm removed from the receptacle exhibits active amœboid movements at its conical end—the pseudopodia arise from folds that branch and anastomose and are capable of sudden, sharp bending movements at the free ends.

The egg shows active streaming currents in the protoplasm and amœboid movements at the end where the polar bodies are forming.

The egg nucleus moves rapidly towards the centre of the egg, apparently owing to the energetic streaming movements of the egg protoplasm, seen chiefly at the polar body end of the egg. This same end shows marked amœboid changes of outline that result in a deep furrow marking off from the larger end with the sperm nucleus a smaller blastomere-like end of the egg with the egg nucleus. The movement of the egg nucleus continues till it reaches the sperm nucleus lying at the pole opposite to the polar bodies.

A centrosphere appears and divides to form a spindle. The two nuclei coming together are flattened against one another and look like vesicles, each with a nucleolus. The spindle lies in the plane between the two nuclei and accompanies them as they slowly move toward the centre of the egg; the migration is accompanied by slow streaming throughout the entire egg and an obliteration of the external furrow that had marked off the egg into blastomere-like portions. In this migration toward the centre, the two nuclei stagger and turn somewhat, without losing their mutual relations of position.

At the centre of the egg the spindle assumes a position to coincide with the long axis of the egg and the two nuclei elongate parallel to it; astral rays become prominent from the ends of the spindle. The cen-

[1] Edited by E. A. Andrews, Baltimore, Md., to whom abstracts, reviews and preliminary notes may be sent.

[2] Biologisches Centralblatt, XVII. No. 4, p. 152–160 and No. 9, p. 339–346.

trospheres swell and a swelling is conspicuous at the equator of the spindle (where reagents show the equatorial plate dividing) while the astral rays become very long aad *curved*, convex towards the egg surface.

The egg protoplasm now begins to move actively again in streams that set the spindle into slow pendulum-like movements. This streaming takes place alternately in each end of the egg and consists of movements from the pole toward the equator.

The cleavage plane appears suddenly as a groove on the surface of the egg at one side, and the internal streaming of protoplasm coming down from the pole towards this equatorial groove *turns inwards and then back towards the pole.* The same takes place on the opposite side of the egg, and the cleavage plane instantly cuts across through the egg.

Amongst unusual cases the author mentions the interesting fact that the movement of the protoplasm may temporarily bend the first cleavage spindle so much that its "fibres" become wave-like, while these same movements may make the astral rays twist into spirals, as seen by Mark in Limax. External pressure exerted on the eggs may bring about the same bending of spindle and rays. The author concludes that all the egg—spindle and astral rays included—is always plastic and liquid, though the material of the spindle of the rays is more viscid than the rest.

After the first division the larger of the two cells soon shows protoplasmic streamings again, and curious ridge-like pseudopodia rise up from its surface near the edge of the cleavage plane. Blunt pseudopodia may form on other parts of the surface, but the amœboid movements of the first two blastomeres are not as pronounced as those of the fertilized egg.

In the second division each cell shows streaming movements from the poles to the equator, and before the cleavage plane appears the spindle is seen to vibrate from side to side.

When the four cells are forming they glide over one another into a new arrangement, and in so doing they are much distorted by pressure—even the spindle within them being distorted.

The paper contains many other interesting facts regarding the cleavage phenomena, both as seen in living and in preserved eggs, but we will only note certain facts that speak for the view of Bütschli as to the vesicular or foam-like structure of protoplasm. Besides all the above facts that show the liquid and viscid state of even the most firm parts of the egg—the fibres—the author sees an appearance of vesiculation at

times in the centrosomes, and the chromosomes may appear rather as hollow vesicles than as solid bodies. The general protoplasm, filled with yolk, showed in some cases a very fine net-alveolar structure in places. On the surface the alveolar layer of Bütschli was always present, and just after the cleavage a very plain cell-plate of Carnoy is regarded and figured by the author as merely the appressed alveolar layers of the two adjacent cells.

PSYCHOLOGY.[1]

Physiological Effects of Mental Work.—Within the present decade the relation between mental work and the bodily processes has been the subject of much study. Interest in the problem as a field for practical inquiry was first aroused by a paper on the fatigue resulting from intellectual work, published by Sikorsky in the *Annales d'hygiène publique* for 1879. He was followed more than ten years later by Burgerstein, Laser, Griesbach and others. In these investigations the method used was that of testing school children in classes. Various problems and exercises were set before them, during and after the school session, and the percentage of errors committed in the operations was taken as measure of the fatigue due to mental work. While some individual errors might be due to other causes, the average percentage of the entire class seemed a fair test of this factor. The latest instances of this method are the investigations of Friedrich and Ebbinghaus described in the May number of the NATURALIST. At about the same time Mosso and his pupils took up the question from another side. They instituted a series of laboratory investigations upon single individuals by means of the ergograph, with a view to determining the fatigue due to steady intellectual, as well as physical work. Kraepelin and his pupils meanwhile undertook the same problem, varying it with tests of the influence of various stimulants and narcotics on the capacity for mental work. They made use of the reaction time method, as well as the percentage of errors. More recently, Binet and his pupils have taken up the subject from a different standpoint, their object being to measure the effect of mental stimulation and mental effort on the bodily processes of breathing, heart action, etc. Several other investi-

[1] Edited by Howard C. Warren, Princeton University, Princeton, N. J.

gators have studied the problem in one or other of these forms, among them may be noted Féré, Patrick and Gilbert, Frey, Bolton, Bergström and Henri.

In an article in the *Année psychologique* for 1896, M. Henri gives a résumé of the various investigations and the methods used in each. He emphasizes the importance of distinguishing the different factors involved in both mental and physical work, and of studying each one separately by appropriate experimental methods. Among these factors he specifies in particular attention, voluntary effort, the psychic processes of memory, and imagination. Little progress has as yet been made in the way of investigating effort except in the study of pathological cases such as aboulia. As for attention, while considerable work has been done in this field, the investigations have generally had for end to determine the mental effects of fatigue and other variations in the conditions, rather than to measure the *physical* effects of variations in the *attention*. Memory has been, perhaps, more systematically studied than any of the other factors.

The investigation of the effect of intellectual work on the pulse and other functions which MM. Binet and Courtier have undertaken seems most likely, of all methods so far devised, to furnish a measure of psychical work in physical terms. A series of papers on the subject by these authors has appeared in the *Année psychologique*, the first in the issue for 1895, and four others in the last volume.[2] In approaching the question it was first of all necessary to study the effect of changes in respiration on the heart beat and blood supply. A large part of the first paper is accordingly taken up with this and with an examination of possible errors in the apparatus. The instrument used was the plethysmograph of Hallion and Conte. This consists of a rubber cylinder, which is grasped firmly by the hand. The outer surface of the hand is covered with a tight-fitting glove, so that any expansion in volume of the hand (due to increased blood pressure) takes effect on the inner surface, and results in diminishing the volume of the rubber cylinder; the latter communicates by means of a tube with a flexible drum. When the cylinder is compressed by the hand the drum rises, and the effect is recorded by means of a pen attached to the drum. The apparatus was found to be very serviceable, and was remarkably free from error. In addition to the frequency and strength of the pulse beat, the dicrotism, or break in the beat, was clearly marked in the diagrams, and proved an important factor in the results.

[2] Vol. III, 1896, published this spring.

MM. Binet and Courtier note the existence of important individual differences in the effects of mental work on the physical processes. In some subjects these are confined almost wholly to changes in the respiration, in others to the action of the heart, while in others they are felt more especially in the vaso-motor system. In general, the effect on the respiration is to make it more rapid and at the same time more superficial. The effects on the pulse curve most frequently observed are: 1st, diminution of amplitude; 2d, diminution of amplitude with change of form; 3d, diminution of amplitude, change of form and lowering of the level of the curve. One or other of these effects appear in almost all the subjects tested.

In their later papers the authors consider in turn the various causes of change in the pulse. They confirm the well-known diurnal changes by numerous observations with their own method, e. g., that the pulse becomes more frequent and the dicrotism generally more marked immediately after a meal. As regards physicial exercise, they lay special stress on the changes that occur in the dicrotism according as the exercise is local, general and moderate, or general and fatiguing.

The study of the effects of mental work is, of course, the most important from the psychological standpoint, and here the authors have sought to combine tests of the heart and respiration with those of the pulse. In addition to the more delicate tests, involving simple mental operations, two of the subjects undertook a piece of severe and prolonged mental work; they spent seven hours working steadily at this task, merely resting at the end of each hour for a time sufficient to perform the necessary tests. Comparing the results with those of a similar period passed under similar conditions but without work, the pulse was found to be considerably retarded in the former case, as compared with the latter, the retardation taking place especially in the early part of the period. The authors sum up their results on mental work as follows: "1. An energetic, but short mental effort produces an excitation of function, vaso-constriction, acceleration of the heart and of the respiration, followed by a very slight retarding of these functions; in some of the subjects a blunting of the dicrotism. 2. Intellectual work lasting for several hours with comparative immobility of the body produces a retardation of the heart and a diminution of the peripheral capillary circulation."

As regards the relation between physical and mental work, the authors are cautious in drawing conclusions. They observe a certain parallelism, in that a single energetic effort produces an acceleration of the heart and lungs, while a long-continued and fatiguing effort fre-

quently weakens the dicrotism. On the other hand, the excitation of the heart is more marked and the acceleration of the respiration greater in physical than in mental work; again, in physical work the respiration grows deeper, while in mental work it becomes more superficial; and finally, prolonged mental work tends to produce a weakening of the peripheral circulation, an effect not observed in the experiments on physical work.

The effects of *emotion* on the heart and pulse are the topic of the last paper by the same authors. The experiments on this difficult problem were contrived with considerable ingenuity. Some of the subjects were children of from 8 to 10, in whom it was easy to excite fear, surprise, pleasure, etc. With adults the tests had to be more carefully planned; a false alarm of fire was prearranged in one case, and resulted in real fear on the part of the subject; another subject after being blind-folded had his hand placed on a pile of worms. A number of tests embodying various emotions were successfully made. It was found that every emotion tended to weaken the pulse; the quality of the emotion, whether pleasurable or painful, had no marked influence—the contrast was altogether between a state of mental rest and one of emotional disturbance. The heart showed a tendency to accelerate when the excitement was strong, and here too no difference was observable between the pleasant and the painful. The influence on the respiration was most marked of all; every emotional excitement produced an acceleration, and at the same time an increase in depth and a shortening of the pause.

The authors added a special study of the effects of music on these functions. Their experiments on this point were confined to one person—a man of fine musical appreciation and with considerable of a musical education; they represent, therefore, merely a single type of individual. There was found to be a distinct, though slight quickening of the respiration and heart in consequence of hearing the tones themselves, and apart from any emotional "echo" aroused by them. When a melody was played, whether sad or gay, the acceleration was more marked, and it reached a climax when the piece was of a dramatic character and particularly fitted to arouse emotion. This acceleration, however, was not accompanied by any noticeable irregularity. There was at the same time in general a weakening of the capillary circulation, which was less when the sounds had merely a sensorial effect than when they produced a distinct emotional disturbance.

In summing up the whole question of emotional effects on the bodily functions, the authors again lay stress on the differences among individ-

uals. From their own observations they are inclined to distinguish three separate classes of effects. 1. In a majority of persons every emotion produces a vascular constriction, an acceleration of the heart and of the respiration, and an increase of amplitude in the thoracic cavity. 2. In some few cases a sensation of pain or an emotion of sorrow may produce a slight retardation of the heart; and 3. It is possible, as observations made on one subject prove, that the form of the capillary pulse may change with the quality of the emotion; this last effect, they remark, may in time enable us to make a classification of the emotions according to their physiological effects on the form of the pulse.—H. C. W.

ANTHROPOLOGY.[1]

Observations on the Scapulæ of Northwest Coast Indians.—Researches on the scapula since the time of Broca's[2] paper in 1878 have not been very numerous or conclusive in their results, and it seems fair to say that the valuable ethnic results which it was expected would be derived from extended observations on the scapula have not proved entirely satisfactory. Nor does it yet seem possible to say whether this is due to the insufficient numbers of scapulæ which have been examined or to individual variation. From an examination of the literature on the subject, especially from the papers of Sir William Turner[3] and Professor Dwight,[4] one would infer that the latter reason is the chief cause for the unsatisfactory results. Indeed, Professor Dwight declares,[5] "I do not know what range of variation a great series of the scapulæ of the larger felidæ might present, but a small one shows nothing like that of the human race—I might even add, that of the Caucasian." It must be confessed, however, that the numbers of observations so far made have been exceedingly small. This is to be explained, of course,

[1] This department is edited by H. C. Mercer, University of Pennsylvania.

[2] "Sur les indices de largeur de l'omoplate chey l'homme," etc., Bull. de la Soc. d'anthropologie de Paris, Feby. 21, 1878.

[3] Challenger report, Zoology, Vol. XVI, "Report on the Human Skeletons," p. 81.

[4] "The Range of Variation of the Human Shoulder-blade," AMERICAN NATURALIST, July, 1887.

[5] "The Range and Significance of Variation in the Human Skeleton," Boston, 1894, p. 23.

in large part, by the fact that even in fairly well preserved skeletons the scapula is extremely likely to be more or less damaged.

With the view of testing some of the conclusions of Professor Dwight, chiefly for my own satisfaction, I made a hasty examination of the scapulæ of the Northwest Coast Indians in the Field Columbian Museum. I was at once surprised at the apparently great individual variation in the general form of the bones, in the surfaces, borders, angles, etc. I then became curious to know if the indices would show a variation correspondingly great. In all I found twenty skeletons, the scapulæ of which were sufficiently well preserved to warrant an examination. Of these, thirteen were of the Kwakiutl race, seven being males and six females; and seven were Songish, four being males and three females.

I have studied topically the following subjects: I. Glenoid cavity; II. Borders and angles; III. Dimensions; IV. Indices; to which is added a general summary.

I. Glenoid Cavity.

My interest in the glenoid cavity was confined to a sexual study of comparative size, and for this purpose two measurements were taken, the maximum length and the maximum width. I made no distinction of race in this study, and measured the cavity of the right bone only. In Table I are given the individual measurements of twenty specimens.

Table I.

Males.		Females.	
Length.	Breadth.	Length.	Breadth.
41 mm.	30 mm.	35 mm.	26 mm.
42	33	34	25
45	28	35	25
44	35	37	26
40	30	35	25
43	30	37	27
40	31	34	24
40	29	34	26
41	31	37	28
40	29		
40	28		

The sharp line of demarkation between the two sexes is perhaps better shown in the following table, where the comparative distribution of the measurements can be seen at a glance:

TABLE II.

Length.	Males.	Females.	Breadth.	Males.	Females.
34 mm.		3	25 mm.		4
35		3	26		3
36			27		1
37		3	28	2	1
38			29	2	
39			30	3	
40	5		31	2	
41	2		32		
42	1		33	1	
43	1		34		
44	1		35	1	
45	1				
Total,	11	9	Total,	11	9
Mean,	41.4	35.3	Mean,	30.3	25.7

Or, to put the result in still another form, we may say the glenoid cavity in the male measures 41 x 30 mm., in the female 35 x 25 mm. According to Professor Dwight the average length in the European male is 39.2 mm., in the female 33.6 mm.

II. Borders and Angles.

a. *Superior Border.*—The superior border necessarily includes a portion of the vertebral border, or at any rate so much of it as is included in the superior angle. As there is no peculiar variation, so far as I can see, which is characteristic of either sex, or is confined to either the Kwakiutl or Songish, I have put into a single group some of the extreme forms. Naturally the chief interest in the superior border centers in the definiteness of the supra-scapular notch. As may be seen in Figure 1 there is an insensible gradation in the series, passing a gradual parabolic curve with no indication of a notch to a well defined notch. Another point to be noted is the very open superior angle which prevails with very few exceptions, and forms a marked contrast to the characteristic pointed termination of the European shoulder-blade.

b. *Vertebral Border.*—Again, as for the superior border, I have treated the collection as a whole, and reproduce here in Fig. 2 some varieties, drawing upon the entire series:

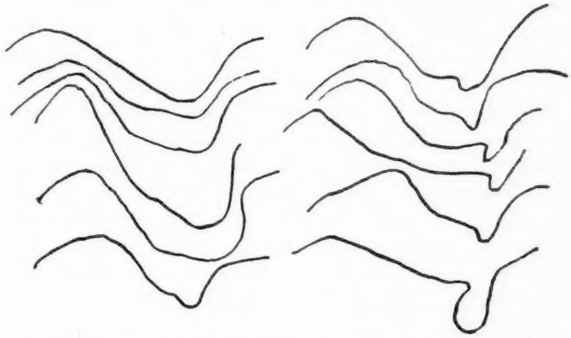

FIG. 1.—Variations in the Superior Border of the Scapula in Northwest Coast Indians. (One-half natural size.)

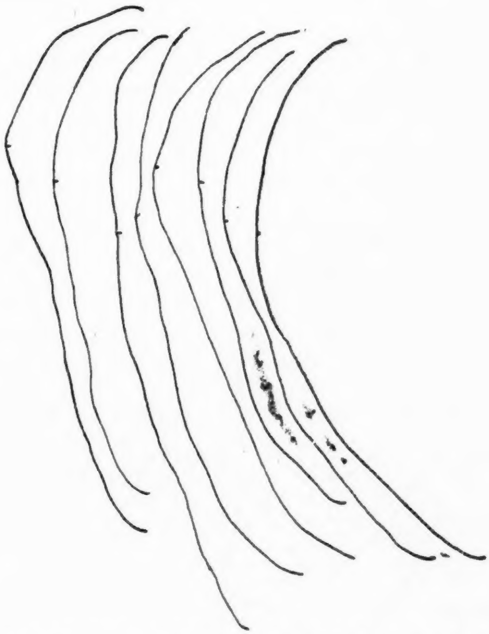

FIG. 2.—Vertebral Border of Scapulæ of Northwest Coast Indians. (One-half natural size.)

c. *Axillary Border and Inferior Angle.*—The variation here equals or even exceeds that of the superior border. This, as is well known, is due very largely to the variations in the attachment surface for the *teres major* muscle. As Professor Dwight here pointed out, this surface is prolonged after the nature of a spinous process in many of the lower monkeys, and has been considered by him as " the appearance of a peculiarity of lower forms "—analogous to the third trochanter. This opinion is, I believe, not generally held by anatomists, the majority preferring to regard the process, when present, as due solely to the influence of an unusually well developed *teres major* muscle. There being thus an unusual amount of interest in this region I have reproduced the outlines (see Figs. 3 and 4) of all the Kwakiutl and Songish scapulæ, keeping the two sexes distinct.

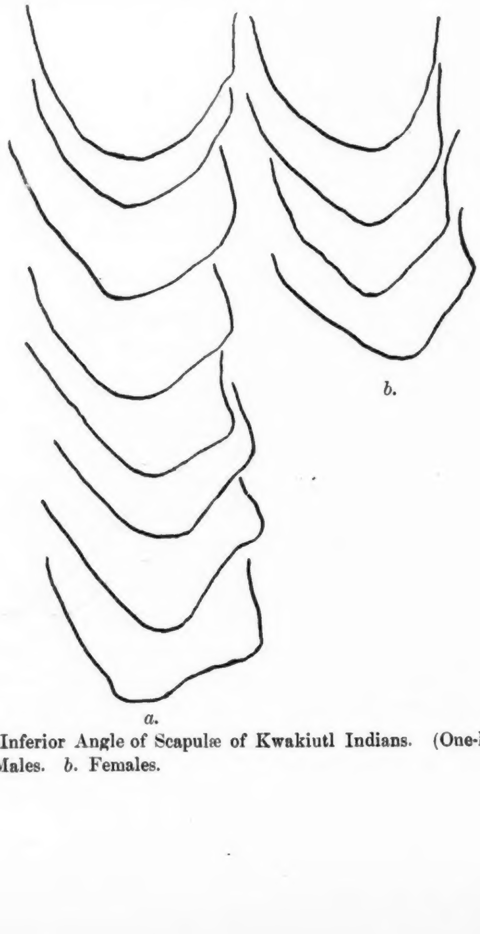

FIG. 3.—Inferior Angle of Scapulæ of Kwakiutl Indians. (One-half natural size.)—*a*. Males. *b*. Females.

It may first be noted in regard to these two sets of outlines that the inferior angle itself is extremely variable. But I entirely agree with

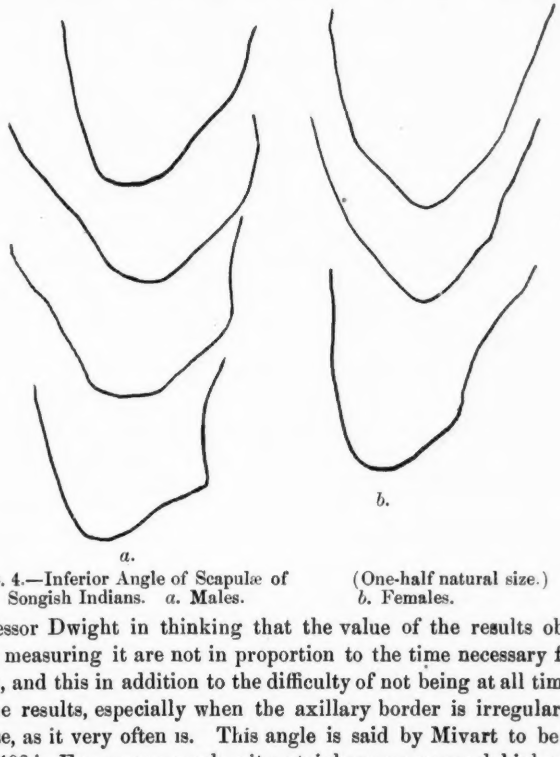

FIG. 4.—Inferior Angle of Scapulæ of Songish Indians. *a.* Males. *b.* Females. (One-half natural size.)

Professor Dwight in thinking that the value of the results obtained from measuring it are not in proportion to the time necessary for the work, and this in addition to the difficulty of not being at all times sure of the results, especially when the axillary border is irregular in its course, as it very often is. This angle is said by Mivart to be about 35°–40° in European scapulæ; it certainly averages much higher in the series under consideration.

In regard to the teres major spine, it seems to be fairly constant in its development in the Kwakiutl males, about equally well developed in the Kwakiutl females and Songish males, and only faintly indicated in the Songish females.

III. Dimensions.

I was interested in four points in the dimensions of the scapulæ, viz.: (a) individual variation; (b) lateral variation; (c) sexual variation; and (d) ethnic variation. These may be seen in the following table.

TABLE III.

		Length.		Breadth.		Infraspinous Length.	
		Right.	Left.	Right.	Left.	Right.	Left.
Kwakiutl	Males.	165 mm.	165 mm.	104 mm.	104	128 mm.	124 mm.
		160	161	110	110	121	121
		160	—	100	94	126	—
		160	160	109	107	122	125
		177	177	—	—	—	—
		159	164	102	104	127	125
		169	169	107	104	133	133
	Females.	154	154	99	100	122	122
		140	130	93	94	111	110
		134	138	84	87	109	109
		140	—	95	—	107	—
		—	—	—	92	—	—
		—	—	—	87	—	113
Songish	Males.	180	172	107	108	140	135
		153	149	98	97	114	115
		177	177	110	110	135	133
		164	160	107	105	122	122
	Females.	138	133	95	95	107	101
		144	—	101	—	111	—
		133	151	95	95	111	115

a. *Individual Variation.*—Taking the entire series as a whole, the range of variation in length is from 130 mm. to 180 mm.; in breadth from 84 mm. to 110 mm.; the infraspinous length from 101 mm. to 140 mm. The greatest contrast is thus, naturally, found in the length, the longest bone exceeding by almost one-third in length the shortest.

b. *Lateral Variation.*—In five instances the right bone is longer than the left, the total aggregate additional length being 31 mm.; in fonr instances the left bone is the longer, the total aggregate additional length being 18 mm. Lateral variation in breadth occurs equally five times for each side, but the total aggregate additional breadth for the right bone is 14 mm., while for the left it is only 8 mm. For the infraspinous length the right bone is the longer six times, with a total of 20 mm., while the left is the longer in three instances with a total of 8 mm. Thus, it may may be seen that the number of instances where some dimension of the right bone exceeds that of the left is sixteen, while in

twelve instances the right exceeds the right in some dimension,—a difference hardly so great as one might expect; and it is possible that a larger series of observations would quite overcome whatever difference seems to exist.

c. *Sexual Variation.*—Taking the scapulæ of the right side only and of the two races together we have the following results, which I have thrown into a Table:

TABLE IV.

	Length.		Breadth.		Infraspinous Length.	
	Male.	Female.	Male.	Female.	Male.	Female.
	mm.	mm.	mm.	mm.	mm.	mm.
Average,	165	141	105	94	125	111

It will thus be seen that the difference in the two sexes is a decided one, and a careful examination of the preceding table shows very few exceptions where the largest female scapula equals in size the smallest of the males.

d. *Ethnic Variation.*—Although the two series are hardly large enough to make it worth while to attempt to draw any conclusions, it would appear that the scapula in the Songish is very slightly larger than it is in the Kwakiutl. This difference is more pronounced in the males than it is in the females.

IV. INDICES.

In Table V the range of variation may be seen for each index, in each sex, and for both races.

The highest scapular index is 70, found in a Songish female; the lowest is 59, in a Songish male. The highest infraspinous index is 90, occurring both in a Songish female and a Kwakiutl male; the lowest is 76, in a Kwakiutl female. Apart from the extremes this table shows two very interesting points; the first is that there is very little sexual variation; the second is that while the scapular index is fairly uniform, the infraspinous index is subject to great variation. The averages of each index for both races are shown in Table VI,

The scapular index of 65.1 for the mean of both races may be regarded, it seems to me, as a trustworthy index for the Northwest Coast Indians. This index, it may be noted, corresponds very closely to that

TABLE V.

Scapular Index.					Infraspinous Index.				
In	Kwakiutl		Songish		In	Kwakiutl		Songish	
Index	♂	♀	♂	♀	Index	♂	♀	♂	♀
59			1		76		1	1	
60					77		1		
61					78				
62	1	1			79	1			
63	2				80	2			
64	1	1	1		81	1	1	1	
65					82				
66		1	1	1	83		1		
67		1	1		84				
68	2			1	85			1	1
69					86				
70				1	87			1	
					88		1		1
					89	1			
					90	1			1
Total,	6	4	4	3	Total,	6	5	4	3
Index,	64.6	64.7	64.0	68.0	Index,	83.6	81.6	82.2	87.6

TABLE VI.

	Scapular Index.	Infraspinous Index.
Kwakiutl,	64.7	82.3
Songish,	65.7	84.5
Both Races,	65.1	83.2

given by previous investigators for European scapulæ; the averages for the latter being 65.9 (Broca), 65.2 (Flower and Garson[6]), 65.2

[6] "On the Scapular Index as a Race Character in Man," Journal of Anatomy and Physiology, Vol. XIV, p. 13.

(Livon[7]), and 63.5 (Dwight). The result is also similar to that obtained by Professor Turner, 65.0, on the scapulæ of nine Fuegians.

The mean infrascapular index of 83.2 does not seem worthy of much consideration, from causes which have already been mentioned. It may be noted, however, that according to the table given by Professor Turner,[8] this index is lower than any yet recorded for any race except the Eskimos, Hottentots and Tasmanians.

Conclusions.

From the present inquiry the following conclusions can be made:

1. There is a marked difference in the size of the scapula in the two sexes; this is seen in the dimensions of the glenoid cavity, and in the length, breadth and infraspinous length.

2. Lateral variations in the scapulæ in linear dimensions are so slight and so contradictory as to be explained perhaps as due to an insufficient number of observations. The right bone is, however, a trifle larger than the left in a small percentage of cases,—this percentage being larger than that of the left bone exceeding the right in size.

3. There is no important difference in the dimensions or indices of the scapula between the Kwakiutl and Songish.

4. There is very little difference in the two indices in the two sexes; the female, perhaps, having indices a trifle higher than the male. This is in accordance with the results of Livon. Broca, on the other hand, considered the male to possess the higher index.

5. The range of variation for the scapular index is not excessive, and there is a certain amount of uniformity in its distribution which makes the mean index of value.

6. The range of variation for the infraspinous index, while not extensive, is so evenly distributed as to destroy in part the value of its mean; and so it cannot be considered to have a value equal to that of the scapular index as representing the average for Northwest Coast Indians.—George A. Dorsey, Ph. G., *Assistant Curator of Anthropology, Field Columbian Museum, Chicago.*

[7] "De l'omoplate et de les indices de largeur dans les races humaines." Thèse, Paris, 1879.

[8] Challenger Report, Vol. XVI, "Report on the Human Skeletons," p. 81.

MICROSCOPY.

Schaper's Method of Reconstruction.[1]—The ingenious method of reconstruction that has been described by Dr. Schaper has considerable advantage over the older method of Born, now long a familiar one in embryological laboratories. The base line of the sections is not at a distance from the section of the object as in the old method, but, on the contrary, is in the edge of the section itself, so that it is always in view, even where the section is so large as to be scarcely included within the field of vision. And one may as safely say that it is fully, if not more accurate than the older method.

Schaper first saturates the embryo with paraffin to prevent its drying and shrinking during the second stage of the process. In this second stage the embryo is taken from the bath and the superabundant melted paraffin removed from it by means of bibulous paper. It is then fastened by a drop of paraffin to a perfectly white piece of bristol-board. This forms a background from which the object stands out in sharp contrast, and allows of a good photograph being taken, or of an accurate outline sketch being made of it with a camera. The photograph or sketch is supposed to represent the natural size of the embryo.

The object is then removed from the bristol-board and replaced in the bath. Next he draws a line on the sketch or photograph just touching the dorsal outline and another one perpendicular to the first just touching the head, thus including the figure within a right angle. A similar right angle is drawn on a piece of cardboard that fits into the imbedding box. The latter is filled with melted paraffin, and then with warm needles the embryo quickly and carefully arranged in the right angle to correspond as closely as possible with the position of the figure in the sketch. The usual process of hardening the paraffin is then gone through and the object is ready for sectioning.

Care is taken in sectioning to have the plane of sectioning perfectly perpendicular to the median plane of the embryo; and, of course, it is assumed that the embryo is as straight as possible. The thickness of 20μ is chosen for the sections as the best, since in thinner ones the internal structures are apt to be broken and thicker ones are not likely to be sufficiently transparent. Sketches of the magnified sections are made on paper, and these, or whatever portion of them may be

[1] Schaper, A. (97). Zur Methodik der Plattenmodellirung. Zeit. Wiss. Mikros., XIII, 4, 446–59.

mounted, later transferred to wax sheets. But a pencil point is first made on the dorsal side of the sketch in the median plane, and sometimes also one in the same plane on the outline of the surface of some central organ, such, for instance, as the neural cord (*r* and *m*, figs. 1 and 2).

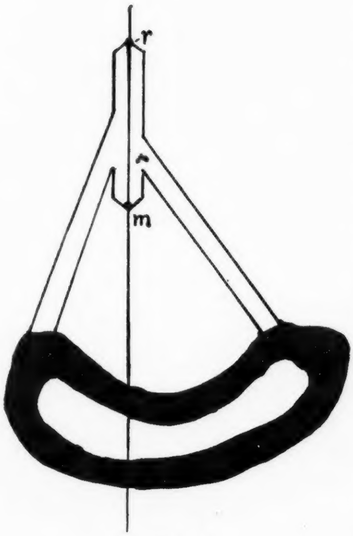

Fig. 1.

The photograph or sketch of the embryo is then enlarged upon a piece of bristol-board to correspond precisely with the magnification of the sections and the enlarged figure cut out with a sharp knife (fig. 2). If only an enlarged model of the entire embryo is desired, the remainder of the process is very short and simple. One has only to arrange the sections of wax representing the sections of the embryo within the bristol-board outline one after another and then smooth off outer surface with a warm modeling tool. If the sections are cut at right angles to the dorsal guide line of the right angle as well as to the median plane, the process will be easier to follow, for then the wax sections can be put in place with reference to this line. And if a model of only a portion of the embryo is desired, the proper place of the wax section in the bristol-board outline may be readily determined from the known thickness of the sections and the numbers in the series of the section with which the reconstruction is begun, by simply measuring off the proper distance on this dorsal guide line. For example, if the sections be 20μ thick, the magnification 100, the number of sections 100, and one desires to reconstruct the middle region of the embryo, beginning with the thirtieth section, the distance will be 20 x 30 x 100 or 60 mm.

If, as is usually the case, one desires a reconstruction of an internal organ, the process is somewhat more complicated. Then one will have need of the second guide point (*m*) already mentioned as on the surface of one of the principal or centrally located organs. In cutting out of

the wax plates the outlines of the sections of the organ to be reconstructed, this point, along with that on the dorsal surface, is cut out so

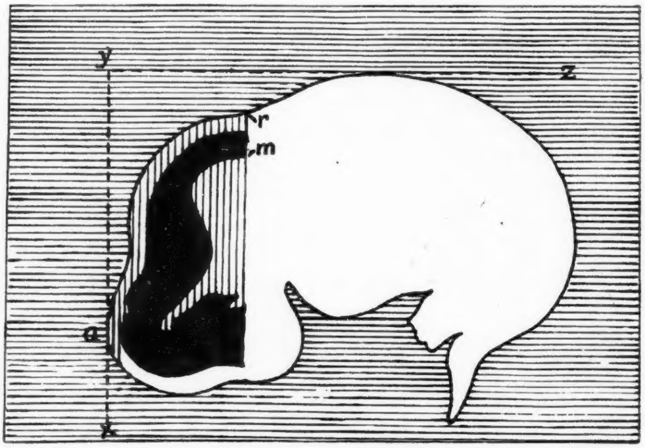

Fig. 2.

Fig. 2.—The Bristol-Board Guide. *x y z*, the dorsal and cephalic guide lines forming the right angle enclosing the figure of the embryo; *r*, the guide point in the dorsal surface and in the median plane; *m*, the guide point in the same plane on the lower surface of the neural cord.

as each to form a point of a piece of wax that remains connected with the sections of the organ by bridges of wax (fig. 1). When the series of wax sections have been cut out, they are then arranged in the bristol board guide in their proper places, care being taken that the two guide points fall within the plane of the bristol-board, and that the line passing through them is perpendicular to the dorsal line of 4–2 (fig. 2). When all are in place, nothing further, of course, remains than to smooth off the outer surface of model.—F. C. Kenyon.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Torrey Botanical Club.—May 11, 1897.—Dr. N. L. Britton presided. Three new members were elected. Three successful excursions were reported. Resolutions were adopted commemorating Dr.

Emily L. Gregory, the late honored Professor of Botany at Barnard College, an active worker in the club. Announcement was made of the gift by President Low to the Botanical Department of Columbia of a valuable set of water-colors to illustrate mushrooms, the work of the late lamented Wm. Hamilton Gibson.

Prof. Britton made a report relative to the progress of the Botanic Garden. A beginning is made in planting the systematic herbaceous garden. Eight acres are set aside for this with the families grouped in beds; the intention is to get as many of each genus together as will grow in this climate in the open. Several hundred species are already in place, and quite a display is already produced by the beds of the Ranunculaceæ, Compositæ, Iridaceæ and Cruciferæ. Seeds of some 3,000 different species are now germinating, including 2,240 species generously sent from Kew. These will be transferred to the herbaceous garden as soon as ready. Meanwhile their permanent stake-labels are in preparation.

The paper of the evening was by Mr. Marshall A. Howe, entitled, "A Preliminary Comparison of the Hepatic Flora of California with that of Europe and of the Eastern United States."

Mr. Howe alluded to the distribution of *Cephalogia turneri*, a rare hepatic of Europe, frequent in the coast ranges of California, and occurring in limited numbers in a few localities in Ireland, England, France and the Mediterranean region.

Mr. Howe presented the following table exhibiting the comparative distribution so far as yet known.

	California.	Gray Manual Reg.
Total number of species	77	145
In common with the British Isles	34 or 44 per cent.	78 or 54 per cent.
In central and northern Europe	40 or 52 per cent.	91 or 63 per cent.
In Mediterranean region	45 or 58½ per cent.	78 or 54 per cent.
Peculiar to Pacific Coast	26 or 34 per cent.	
In common with the Gray Manual Region	37 or 48 per cent.	
Peculiar to Gray Manual Region		40 or 28 per cent.
In common with California		32 or 22 per cent.

It was shown that the hepatic flora of California has more in common with northern and central Europe than with the eastern United States, and is still more allied to that of the Mediterranean region. In particular species of Astorella and Riccia are better developed in California and southern Europe than in the eastern United States.

The apparent absence in California of Bazzania and Mylia, which are especially characteristic of medial and boreal regions, serves to heighten the similarity to southern Europe.

The paper was followed by exhibit of photomicrographs of sections of Cryptomitrium, illustrating the development of the archegonia.

In the discussion following, Prof. Underwood said that Hepatic species are most numerous in the Amazon region and the eastern slope of the Andes and in Java. Insular tropical regions have furnished many where examined, as Cuba and Jamaica. Quite a number are peculiar to Australia. New Zealand is well-supplied with species. Many have been recently collected in Africa, and have been described by Herr Stephani, of Leipsic, whose industry has doubled the number of described Hepaticæ. As a whole, the maximum development of the Hepaticæ is tropical, though some genera and certain groups within genera are wholly high-temperate or subarctic.

Prof. Britton remarking the indications of circumboreal and circumtropical distribution of certain species, referred to the argument for an equatorial distribution of flowering plants and of ferns, and queried if there were anything corresponding among Hepaticæ. He expressed the belief that it is the immediate environment which at present exerts the principal influence on distribution, whatever the original cause or mode of distribution may have been.

Prof. Underwood referred to the influence of the Gulf Stream in permitting the existence of the subtropical genus Lejeunia on the coast of Ireland, a genus not elsewhere found in Europe. Comparing the Hepaticæ of Florida, they are only in part known; a few species are in common with the Appalachian flora; most of the Florida hepatica are close-creeping forms found on bark, as *Frullania* and *Lejeunia*, having water sacs on their leaves as aid in resisting drought. Some tropical *Marchantiaceæ* occur in Florida, and also, especially, species of *Riccia* and *Anthoceros*. *Thallocarpus* is known only from Florida and South Carolina. Adjourned to May 26.

May 26, 1897.—The President, Hon. Addison Brown presided. The evening was devoted to a lecture by Mrs. Elizabeth A. Britton, entitled "The Moss Flora of the Adirondack Mountains," illustrated by lantern slides prepared by Mr. C. H. Van Brunt, and also by about 150 mounted sheets displaying specimens collected by Mrs. Britton in the vicinity of Adirondack Lodge and Lake Placid in the years 1892, 1894 and 1896. Their various habitats were described, with the story of a climb up Whiteface. About 30 rare species were enumerated, including *Raphidostegium jamesii* not previously reported from New York

State, and *Bryum conciunatum*, found only once before in the United States. Duplicates of Mrs. Britton's collection have been deposited at the State Herbarium in Albany, the main collection having been presented to the Herbarium of Columbia University. Partial sets were sent to the Brooklyn Institute, Cornell University and other collections.

After discussion by Mr. A. P. Grout, Mrs. Britton and others, the Club adjourned to the second Tuesday in October, field-meeting continuing meantime on Saturdays.—EDWARD S. BURGESS, *Secretary.*

SCIENTIFIC NEWS.

The College of Agriculture of the University of California at Berkeley was recently destroyed by fire, the loss amounting to $20,000. The building was of comparatively little value as the department had outgrown it.

Natural Science again changes publishers. With the beginning of the eleventh volume this valuable journal will be issued from the press of J. M. Dent & Co., 67 St. James St., London.

Recent Appointments, America : Robert B. Yound, assistant biologist in the department of Agriculture; Frederick L. Ransome, assistant geologist on the U. S. Geological Survey ; Herbert Richards, tutor in botany in Columbia University ; Jas. H. McGregor, assistant in zoology Columbia University ; Dr. Frederick D. Lambert, assistant in biology, Tufts College ; C. H. Townsend, chief of division of fisheries, U. S. Fish Commission ; Dr. H. M. Smith, chief of the division of scientific enquiry, U. S. Fish Commission ; J. F. Crawford, demonstrator of experimental psychology at Princeton ; J. H. Pratt, mineralogist to the North Carolina Geological Survey; T. A. Reakard, state geologist of Colorado. At Johns Hopkins University: Dr. J. M. T. Finney, professor of surgery ; Dr. J. E. Humphrey, associate professor of botany ; Dr. J. B. Shattuck, assistant in geology ; Dr. C. R. Bardeen, assistant in anatomy ; Mr. F. C. Connant, Bruce fellow in zoology ; Mr. Cleveland Abbe, Jr., fellow in geology ; Mr. G. A. Drew, fellow in biology ; Mr. C. W. Greene, fellow in biology ; Mr. J. L. Nichols, fellow in pathology. Other American appointments are : Dr. Charles E. Beecher, professor of historical geology at Yale University ; Dr. L. V. Pirsson, professor

of physical geology at the Lawrence Scientific school; Dr. Charles Norris, tutor in pathology at Columbia University; Dr. E. B. Copeland, assistant professor of botany at the University of Indiana.

Germany: Dr. K. von Buchku, director of the department of scientific enquiry at the sanitary office, Berlin; Dr. Jensen, privat-docent in physiology in the University of Halle; Dr. Max Siegfried, professor extraordinarius of physiology at Leipzig: Dr. Fritz Noll, professor of physiology at the University of Heidelberg; Dr. E. Kaufmann, professor of anatomy at Bonn; Dr. Max Walters, professor extraordinarius of anatomy at Bonn; Dr. Ludwig Heim, professor extraordinarius of bacteriology at Marburg; Dr. Noll, professor of botany at Bonn; Dr. Siedentopf of Göttingen assistant in mineralogy at Griefsorald; Dr. Beckenkamp, professor of mineralogy at Würzburg; Dr. E. A. Wülfing, professor extraordinarius of mineralogy at Lubingen; Dr. Paul Samassa, associate professor of zoology in the University of Heidelberg.

Austria: Wladislow Szymonowicz, professor extraordinarius of histology and embryology at Lemburg; Victor Folgner, assistant in the botanical institute of the German University of Prag; Anton Heinz, professor of botany at Agram; Dr. Mijat Kispatitch, professor of mineralogy at Agram.

Great Britain: F. F. Blackman, lecturer in botany at Cambridge.

Other Countries: Dr. J. L. Prevost, professor of physiology at Geneva; A. Gibb Martland, of the Innusland Geological Survey, geologist of West Australia; Dmitri Klemenz, Curator of the Museum of the Petersburg Academy of Sciences; Dr. Velain, professor of physical geography in the University of Paris.

Mr. A. Smith Woodward, of the paleontological department of the British Museum presents an appreciation sketch of the late Professor Cope in the June number of Natural Science.

The Academy of Natural Sciences of Philadelphia, is trying to raise $50,000 to purchase the paleontological collections of Professor Cope. Since the fund received from the sale of the collections is to go to the Academy for the foundation of a professorship of paleontology it would seem appropriate that the collections themselves should become the property of this society.

Fritz Müller, well-known for his investigations upon the history of the white ants, the embryology of Crustacea and especially for his sugges-

tive little volume "Für Darwin" died at Blumenau, Brazil, May 21, 1897, at the age of 75.

Dr. John Murray had just opened a new biological station at Millport, on the Clyde.

Prof. Jacob G. Agardh, of Lund, the well known student of sea weeds, secures the gold medal of the Linnean Society of London.

From *Science* we learn that the United States Geological Survey has appropriations for the present fiscal year as follows: The topographical surveys \$175,000; for geological surveys and researches \$100,000; for investigation of coal and gold in Alaska \$5,000; paleontology \$10,000; chemistry \$7,000; gauging streams and water supply, \$50,000; numeral resources \$20,000. Besides there are allowances for illustrations, printing, etc. The same bill also appropriates large sums for other surveys of the public forest lands; Indian Territory, etc.

The Museum at Bergen, Norway, has for several years been very active and now is to be enlarged, the government furnishing half of the \$40,000 required for the addition. Over 50,000 people visited the museum in 1896.

The Field Columbia Museum of Chicago, has purchased the Schott collection of plants.

We have often had occasion to speak of appointments to scientific office in the State of Indiana and Illinois. Illinois has again emphasized the domination of the politician in these matters by the appointment of a steamboat agent, Mr. C. H. Cranz, to the office of State Geologist and curator of the state museum; while Kentucky is adopting a similar course if the recent appointment of G. W. Stone, a lawyer and a politician, to be inspector of mines be any criterion.

Natural Science makes the astonishing statement that the tanks of the Port Evin Biological Station now contain "a cross between Myxine and the cod."

Recent Deaths: Max Sintenis, entomologist at Kupferberg, Silesia; Filipps Tognini, curator of botany in the University of Paris; M. Thollen, botanist, at Libreville, Africa, in January; G. Gercke, student of diptera at Hamburg; J. B. Barla, director of the Museum at Nizza; Dr. Julius Sachs, professor of botany in the University of Würtzburg; Sir Edward Newton, ornithologist; Abraham der Bartlett, superintendent of the London Zoological Gardens.

An important change has been effected at the National Museum by which the various departments of the institution have been divided into three sections—anthropology, biology and geology. The object is to secure a more simple administration of the museum's affairs.

Head curators, each with a salary of $3500 a year, have been appointed from the present museum personnel, as follows: Anthropology, Professor W. H. Holmes; biology, Dr. Frederick W. True, executive curator of the museum, which office he will also retain; geology, Dr. George P. Merrill, Professor of Geology in Columbian University.

A herd of some seventy or eighty buffaloes has been discovered in the northwestern part of Buchel County, Texas.

Trinity University, of Toronto, Ont., has offered the honorary degree of D. C. L. to the following members of the British Association: Sir John Evans, President of the association; Lord Rayleigh, Lord Lister, Sir John Lubbock, and Prof. Forsythe, of Cambridge.

The viticultural services of the late Professors P. Duchartre and F. Laforgue are to be commemorated by marble plates in the houses in which they were born. Both were born in the neighborhood of Béziers. The former in 1806.

Mr. A. W. Bennett has been appointed by the council of the Royal Microscopical Society to edit the well known journal of the society previously edited by Prof. F. J. Bell.

Dr. C. A. White and Mr. Charles Schuchert have gone under orders from the U. S. National Museum to join the Peary expedition to the Arctic regions. Their party will be put ashore at Disco island to explore the island for fossils, while awaiting the return of Lieut. Peary's vessel.

Mr. Currie, who accompanied Prof. O. F. Cook to Liberia, Africa, has returned, and reports that a large collection of insects and animals has been made. Prof. Cook is expected in August.